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## THE EARLY DISCIPLINE OF MANKIND.[1]

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BY far the greatest advantage is that on which I observed before —that to which I drew all the attention I was able by making the first of these essays an essay on the Preliminary Age. The first thing to acquire is, if I may so express it, the *legal fibre;* a polity first—what sort of polity is immaterial; a law first—what kind of law is secondary; a person or set of persons to pay deference to—though who he is, or they are, by comparison scarcely signifies.

"There is," it has been said, "hardly any exaggerating the difference between civilized and uncivilized men; it is greater than the difference between a tame and a wild animal," because man can improve more. But the difference at first was gained in much the same way. The taming of animals, as it now goes on among savage nations, and as travellers who have seen it describe it, is a kind of selection. The most wild are killed when food is wanted, and the most tame and easy to manage kept, because they are more agreeable to human indolence, and so the keeper likes them best. Captain Galton, who has often seen strange scenes of savage and of animal life, had better describe the process: "The irreclaimably wild members of every flock would escape and be utterly lost; the wilder of those that remained would assuredly be selected for slaughter whenever it was necessary that one of the flock should be killed. The tamest cattle—those which seldom ran away, that kept the flocks together, and those which led them homeward—would be preserved alive longer than any of the others. It is, therefore, these that chiefly become the parents of stock and bequeath their domestic aptitudes to the future herd. I have constantly

[1] From advance-sheets of "Physics and Politics," forming vol. ii. of "The International Scientific Series." The present article is a portion of Mr. Bagehot's chapter on "The Use of Conflict."

witnessed this process of selection among the pastoral savages of South Africa. I believe it to be a very important one on account of its rigor and its regularity. It must have existed from the earliest times, and have been in continuous operation, generation after generation, down to the present day." [1]

Man, being the strongest of all animals, differs from the rest; he was obliged to be his own domesticator; he had to tame himself. And the way in which it happened was, that the most obedient, the tamest tribes are, at the first stage in the real struggle of life, the strongest and the conquerors. All are very wild then; the animal vigor, the savage virtue of the race has died out in none, and all have enough of it. But what makes one tribe—one incipient tribe, one bit of a tribe—to differ from another is their relative faculty of coherence. The slightest symptom of legal development, the least indication of a military bond, is then enough to turn the scale. The compact tribes win, and the compact tribes are the tamest. Civilization begins, because the beginning of civilization is a military advantage.

Probably if we had historic records of the ante-historic ages—if some superhuman power had set down the thoughts and actions of men ages before they could set them down for themselves—we should know that this first step in civilization was the hardest step. But, when we come to history as it is, we are more struck with the difficulty of the next step. All the absolutely incoherent men—all the "Cyclopes"—have been cleared away long before there was an authentic account of them. And the least coherent only remain in the "protected" parts of the world, as we may call them. Ordinary civilization begins near the Mediterranean Sea; the best, doubtless, of the ante-historic civilizations were not far off. From this centre the conquering *swarm*—for such it is—has grown and grown; has widened its subject territories steadily, though not equably, age by age. But geography long defied it. An Atlantic Ocean, a Pacific Ocean, an Australian Ocean, an unapproachable interior Africa, an inaccessible and undesirable hill India, were beyond its range. In such remote places there was no real competition, and on them inferior, half-combined men continued to exist. But in the regions of rivalry—the regions where the better man pressed upon the worse man—such half-made associations could not last. They died out, and history did not begin till after they were gone. The great difficulty which history records is not that of the first step, but that of the second step. What is most evident is not the difficulty of getting a fixed law, but getting out of a fixed law; not of cementing (as upon a former occasion I phrased it) a cake of custom, but of breaking the cake of custom; not of making the first preservative habit, but of breaking through it, and reaching something better.

This is the precise case with the whole family of arrested civiliza-

[1] "Ethnological Society's Transactions," vol. iii., p. 137.

tions. A large part, a very large part, of the world seems to be ready to advance to something good—to have prepared all the means to advance to something good—and then to have stopped, and not advanced. India, Japan, China, almost every sort of Oriental civilization, though differing in nearly all other things, are in this alike. They look as if they had paused when there was no reason for pausing—when a mere observer from without would say they were likely not to pause.

The reason is, that only those nations can progress which preserve and use the fundamental peculiarity which was given by Nature to man's organism as to all other organisms. By a law of which we know no reason, but which is among the first by which Providence guides and governs the world, there is a tendency in descendants to be like their progenitors, and yet a tendency also in descendants to *differ* from their progenitors. The work of Nature in making generations is a patchwork—part resemblance, part contrast. In certain respects each born generation is not like the last born; and in certain other respects it is like the last. But the peculiarity of arrested civilization is to kill out varieties at birth almost; that is, in early childhood, and before they can develop. The fixed custom which public opinion alone tolerates is imposed on all minds, whether it suits them or not. In that case the community feel that this custom is the only shelter from bare tyranny, and the only security for what they value. Most Oriental communities live on land which in theory is the property of a despotic sovereign, and neither they nor their families could have the elements of decent existence unless they held the land upon some sort of fixed terms. Land in that state of society is (for all but a petty skilled minority) a necessary of life, and, all the unincreasable land being occupied, a man who is turned out of his holding is turned out of this world, and must die. And our notion of written leases is as out of place in a world without writing and without reading as a House of Commons among Andaman-Islanders. Only one check, one sole shield for life and good, is then possible—usage. And it is but too plain how in such places and periods men cling to customs because customs alone stand between them and starvation.

A still more powerful cause coöperated, if a cause more powerful can be imagined. Dryden had a dream of an early age, "when wild in woods the noble savage ran;" but "when lone in woods the cringing savage crept" would have been more like all we know of that early, bare, painful period. Not only had they no comfort, no convenience, not the very beginnings of an epicurean life, but their mind within was as painful to them as the world without. It was full of fear. So far as the vestiges inform us, they were afraid of every thing; they were afraid of animals, of certain attacks by near tribes, and of possible inroads from far tribes. But, above all things, they were frightened of "the world;" the spectacle of Nature filled them with awe and dread. They fancied there were powers behind it which must

be pleased, soothed, flattered, and this very often in a number of hideous ways. We have too many such religions, even among races of great cultivation. Men change their religions more slowly than they change any thing else; and accordingly we have religions "of the ages" (it is Mr. Jowett who so calls them)—of the "ages before morality;" of ages of which the civil life, the common maxims, and all the secular thoughts, have long been dead. "Every reader of the classics," said Dr. Johnson, "finds their mythology tedious." In that old world, which is so like our modern world in so many things, so much more like than many far more recent, or some that live beside us, there is a part in which we seem to have no kindred, which we stare at, of which we cannot think how it could be credible, or how it came to be thought of. This is the archaic part of that very world which we look at as so ancient; an "antiquity" which descended to them, hardly altered, perhaps, from times long antecedent, which were as unintelligible to them as to us, or more so. How this terrible religion—for such it was in all living detail, though we make, and the ancients then made, an artistic use of the more attractive bits of it—weighed on man, the great poem of Lucretius, the most of a nineteenth-century poem of any in antiquity, brings before us with a feeling so vivid as to be almost a feeling of our own. Yet the classical religion is a mild and tender specimen of the preserved religions. To get at the worst, you should look where the destroying competition has been least—at America, where sectional civilization was rare, and a pervading coercive civilization did not exist; at such religions as those of the Aztecs.

At first sight it seems impossible to imagine what conceivable function such awful religions can perform in the economy of the world. And no one can fully explain them. But one use they assuredly had: they fixed the yoke of custom thoroughly on mankind. They were the prime agents of the era. They put upon a fixed law a sanction so fearful that no one could dream of not conforming to it.

No one will ever comprehend the arrested civilizations unless he sees the strict dilemma of early society. Either men had no law at all, and lived in confused tribes, hardly hanging together, or they had to obtain a fixed law by processes of incredible difficulty. Those who surmounted that difficulty soon destroyed all those that lay in their way who did not. And then they themselves were caught in their own yoke. The customary discipline, which could only be imposed on any early men by terrible sanctions, continued with those sanctions, and killed out of the whole society the propensities to variation which are the principle of progress.

Experience shows how incredibly difficult it is to get men really to encourage the principle of originality. They will admit it in theory, but in practice the old error—the error which arrested a hundred civilizations—returns again. Men are too fond of their own life, too credulous of the completeness of their own ideas, too angry at the pain of

new thoughts, to be able to bear easily with a changing existence; or else, *having* new ideas, they want to enforce them on mankind—to make them heard, and admitted, and obeyed before, in simple competition with other ideas, they would ever be so naturally. At this very moment there are the most rigid Comtists teaching that we ought to be governed by a hierarchy—a combination of *savants* orthodox in science. Yet who can doubt that Comte would have been hanged by his own hierarchy; that his *essor matériel*, which was, in fact, troubled by the "theologians and metaphysicians" of the Polytechnic School, would have been more impeded by the government he wanted to make? And then the secular Comtists, Mr. Harrison and Mr. Beesly, who want to "Frenchify the English institutions"—that is, to introduce here an imitation of the Napoleonic system, a dictatorship founded on the proletariat—who can doubt that, if both these clever writers had been real Frenchmen, they would have been irascible anti-Bonapartists, and have been sent to Cayenne long ere now? The wish of these writers is very natural. They want to "organize society," to erect a despot who will do what they like, and work out their ideas; but any despot will do what he himself likes, and will root out new ideas ninety-nine times for once that he introduces them.

Again, side by side with these Comtists, and warring with them—at least, with one of them—is Mr. Arnold, whose poems we know by heart, and who has, as much as any living Englishman, the genuine literary impulse; and yet, even he wants to put a yoke upon us—and, worse than a political yoke, an academic yoke, a yoke upon our minds and our styles. He, too, asks us to imitate France.

Asylums of commonplace, as Béranger hints, academies must ever be. But that sentence is too harsh; the true one is, the academies are asylums of the ideas and the tastes of the last age. "By the time," I have heard a most eminent man of science observe, "by the time a man of science attains eminence on any subject, he becomes a nuisance upon it, because he is sure to retain errors which were in vogue when he was young, but which the new race have refuted." These are the sort of ideas which find their home in academies, and out of their dignified windows pooh-pooh new things.

I may seem to have wandered far from early society, but I have not wandered. The true scientific method is to explain the past by the present—what we do not see by what we see. We can only comprehend why so many nations have not varied, when we see how hateful variation is; how everybody turns against it; how not only the conservatives of speculation try to root it out, but the very innovators invent most rigid machines for crushing the "monstrosities and anomalies," the new forms, out of which, by competition and trial, the best is to be selected for the future. The point I am bringing out is simple: one most important prerequisite of a prevailing nation is that it should have passed out of the first stage of civilization into the sec-

ond stage—out of the stage where permanence is most wanted, into that where variability is most wanted; and you cannot comprehend why progress is so slow, till you see how hard the most obstinate tendencies of human nature make that step to mankind.

Of course the nation we are supposing must keep the virtues of its first stage as it passes into the after-stage, else it will be trodden out; it will have lost the savage virtues in getting the beginning of the civilized virtues; and the savage virtues which tend to war are the daily bread of human nature. Carlyle said, in his graphic way, "The ultimate question between every two human beings is, 'Can I kill thee, or canst thou kill me?'" History is strewn with the wrecks of nations which have gained a little progressiveness at the cost of a great deal of hard manliness, and have thus prepared themselves for destruction as soon as the movements of the world gave a chance for it. But these nations have come out of the "preëconomic stage" too soon; they have been put to learn while yet only too apt to unlearn. Such cases do not vitiate, they confirm, the principle—that a nation which has just gained variability, without losing legality, has a singular likelihood to be a prevalent nation.

No nation admits of an abstract definition; all nations are beings of many qualities and many sides; no historical event exactly illustrates any one principle; every cause is intertwined and surrounded with a hundred others. The best history is but like the art of Rembrandt: it casts a vivid light on certain selected causes, on those which were best and greatest; it leaves all the rest in shadow and unseen. To make a single nation illustrate a principle, you must exaggerate much and you must omit much. But, not forgetting this caution, did not Rome—the prevalent nation in the ancient world—gain her predominance by the principle on which I have dwelt? In the thick crust of her legality there was hidden a little seed of adaptiveness. Even in her law itself no one can fail to see that, binding as was the habit of obedience, coercive as use and wont at first seem, a hidden impulse of extrication *did* manage, in some queer way, to change the substance while conforming to the accidents—to do what was wanted for the new time, while seeming to do only what was directed by the old time. And the moral of their whole history is the same: each Roman generation, so far as we know, differs a little—and in the best times often but a *very* little—from its predecessors. And, therefore, the history is so continuous as it goes, though its two ends are so unlike. The history of many nations is like the stage of the English drama: one scene is succeeded on a sudden by a scene quite different—a cottage by a palace, and a windmill by a fortress. But the history of Rome changes as a good diorama changes: while you look, you hardly see it alter; each moment is hardly different from the last moment; yet at the close the metamorphosis is complete, and scarcely any thing is as it began. Just so in the history of the great

prevailing city: you begin with a town and you end with an empire, and this by unmarked stages. So shrouded, so shielded, in the coarse fibre of other qualities, was the delicate principle of progress, that it never failed, and it was never broken.

One standing instance, no doubt, shows that the union of progressiveness and legality does not secure supremacy in war. The Jewish nation has its type of progress in the prophets, side by side with its type of permanence in the law and Levites, more distinct than any other ancient people. Nowhere in common history do we see the two forces—both so necessary, and both so dangerous—so apart, and so intense: Judea changed in inward thought, just as Rome changed in exterior power. Each change was continuous, gradual, and good. In early times every sort of advantage tends to become a military advantage; such is the best way, then, to keep it alive. But the Jewish advantage never did so; beginning in religion, contrary to a thousand analogies, it remained religious. *For* that we care for them; *from* that have issued endless consequences. But I cannot deal with such matters here, nor are they to my purpose. As respects this essay, Judea is an example of combined variability and legality not investing itself in warlike power, and so perishing at last, but bequeathing, nevertheless, a legacy of the combination in imperishable mental effects.

It may be objected that this principle is like saying that men walk when they do walk, and sit when they do sit. The problem is, Why do men progress? And the answer suggested seems to be, that they progress when they have a certain sufficient amount of variability in their nature. This seems to be the old style of explanation by occult qualities. It seems like saying that opium sends men to sleep because it has a soporific virtue, and bread feeds because it has an alimentary quality. But the explanation is not so absurd. It says: "The beginning of civilization is marked by an intense legality; that legality is the very condition of its existence, the bond which ties it together; but that legality—that tendency to impose a settled customary yoke upon all men and all actions—if it goes on, kills out the variability implanted by Nature, and makes different men and different ages facsimiles of other men and other ages, as we see them so often. Progress is only possible in those happy cases where the force of legality has gone far enough to bind the nation together, but not far enough to kill out all varieties and destroy Nature's perpetual tendency to change." The point of the solution is not the invention of an imaginary agency, but an assignment of comparative magnitude to two known agencies.

# THE COATI-MONDI AND ITS COUSINS.

By Rev. S. LOCKWOOD, Ph. D.

SAILORS from South America occasionally, among other pets, bring a small animal, which, because of its long nose, they invariably call an Ant-eater. Thus was a little stranger introduced to our care a few years ago. A glance was enough to see that it was no ant-eater at all, but a pretty female Coati-Mondi. Gallant Jack Tar, her master on ship, unconscious of the incongruity, had made a namesake of her, and called her Jack. Science had already named her Nasua, and in a matter-of-fact way, for the word interpreted just means—Nosie. The animal was about the size of a cat, with a thick, coarse fur, of a brownish hue on the back and sides, and underneath shades from yellow to orange. The long tail was ornamented by a series of black and yellowish-brown rings. Her nasal prominence reminded me of a queer Spaniard, once employed in the government service to detect spurious coin. His "counterfeit detector" was a sensitive proboscis. By sticking this organ into the glittering heaps he literally "nosed" out the bad from the good. To that man his nose was the instrument of his profession; and to Nasua her nose was equally important. It even prompted a nick-name and a juvenile pun—"Nosie's nose knows too much!" Inappeasably inquisitive, she was incessantly intruding that organ into every thing. Having made no allowance for an extra-tropical temperature, this little South American made a failure in an attempt to lift with her nose the lid of a pot in the cook's domain. The next attempt, a successful one, was on the knife-box, whose closely-fitting lid was pried open, and every article inspected, in happy ignorance of the proverb about edged tools. It was enough that any thing was hollow to excite her curiosity, which was of a thoroughly simian type. The dinner-bell was turned over; but, unable to detach the clapper and chain, it was soon abandoned in disgust. A round sleigh-bell received more persevering attention. Unable to get her nose or paws into the little hole at the side, the clatter within set her wild with excitement, and evoked a desperate attack on the little annoyance with her teeth. She then gave it up as a bootless job. A bottle of hartshorn was next made the subject of investigation. We had purposely loosened the cork, and promised ourselves a "nice sell;" and *we* got it—not Nosie. She was not in the least disconcerted by the drug. In fact, she had a strong nose for such things. A man gave her his tobacco-box. Resting it on the floor between her two paws, which possessed uncommon flexibility, she turned it over and over, round and round, exercising alternately her nose, claws, and teeth upon it with great energy, but to no avail. It seemed that the smell of its contents infatuated her, as she showed no disposition to

stop. The man opened the box for her. She was in rapture. In went the nose, also both front paws. Very soon that wonderfully mobile organ had separated every fibre, so that the mass seemed trebly increased. The same man let her have his dirty pipe, when her velvety nose was instantly squeezed into the rank nicotian bowl.

It would be wrong to infer that Nasua's prying propensity never got her into trouble. In the following instance, speaking metaphorically, she put her foot into it: The old cat had just finished her nap, and was stretching herself, an operation which means that she stood with her four feet close together, the limbs elongated, the back rounded up like that of a camel, the head erect and drawn back, and the mouth yawning widely. Such a sight Nosie had never seen, hence it must

FIG. 1.

*Coati-Mondi* (Nasua fusca) A native of South America. The full-grown animal is about the size of the domestic cat. Compare its bear-like step with Fig. 4.

be looked into. So in a trice, erect, and resting flatly on her hind-feet like a little bear, she put her arms round Tabbie's neck, and, reeking with nicotine, down went that inquisitive nose into the depths of the feline fauces. This unwarrantable intrusion was met by a reception more feeling than felicitous, judging from the haste in which Nasua withdrew to a corner of the room to ruminate on the untoward incident. Her method of relieving the injured member was itself original. She placed it between her paws, holding it tightly, then jerked it through them, giving a violent sneeze every time it came out. That

sneezing was genuine, because it was involuntary. Both hartshorn and nicotine had signally failed to get up any thing respectable in that line; but that cat-nip, pure and simple, did the business finely.

Quite pretty was the pattern of the animal's ears—they were so clean, trim, soft, and small. Though rather pert, they had an air about them that was really amiable, and such as the canine fancier would pronounce elegant. She was not averse to a little fondling, and I well remember the first time she climbed upon my lap. Those pretty ears suddenly quivered. The ticking of my watch had excited her. Down goes that ubiquitous utilitarian organ into the watch-pocket. Failing with the nose, she makes a desperate effort with that and both fore-feet all at once. Still unable to evict that case of mystery, she thrusts her nose down by its side, and for several minutes, with simian quaintness, listens to the ticking of mortal Time.

FIG. 2.

*Coati-Mondi asleep.* (Original.) Compare the snout with those of the three pachyderms, Figs. 5, 6, and 7. It agrees functionally, and, in the main, structurally, with that of the Swine, Fig. 6, and with that of the Peccary, Fig. 5. The Peccary snout, too, approaches it in flexibility. But the Tapir, Fig. 7, surpasses it in this particular. In the cut, which is excessively foreshortened, the sleeping animal is using its tail as a cushion for the head.

On the above occasion Coati was allowed the liberty often taken by the little dog, of going to sleep on my lap, while I gave myself up to the enjoyment of my book. Her nap finished, I did not notice when she left my lap. Soon a noise was heard like the tearing of paper. The wonderful little beast had abstracted my pocket-diary, and in violation of all propriety was making heavy extracts in a litter-ary way. Those keen incisors were scissoring away—a full leaf at a time! She had even filched a five-dollar note out of the pouch of the book, and, by way of change, had converted it into fractional currency.

In the same manner, though not to the same extent, the nose of the Nasua, like the same organ of the elephant, projects far beyond the mouth. At our first acquaintance with the animal, we were anxious to see if it could drink out of a deep, narrow vessel. So a mug, containing about a gill of milk, was set before her. She instantly turned up the proboscis toward her forehead, and, in the easiest way imaginable, lapped the vessel dry. The organ was not even wet. The sight, though comical, was really pretty. It was the only time that I had ever seen the turning up of the nose at one's friends so deftly and gracefully done. And she could turn the same organ in a contrary way quite as easily. The first time she confronted a mirror, startled at beholding her own counterfeit presentment, instantly her countenance fell—very low indeed; for her nose bent downward, and actually curved under the chin. Of course the word chin is not here anatomically correct. Her proboscis now looked like that of a tapir in repose. This singular grimace, with its squeaky little grunts, presented a very funny manifestation of surprise.

FIG. 3.

*Raccoon* (Procyon lotor). A near ally of the Coati-Mondi, having the same plantigrade, or bear-like step, and certain other resemblances of form and habit. The tail is too short in the cut, which is due to the foreshortening.

Sometimes for an airing the animal was tied by a long tether to a flower-stand on the lawn. It should have been mentioned that she was literally omnivorous. She would catch a mouse and eat it all up. The heads of poultry given her in the kitchen would be eaten ravenously. The same is true of sweetmeats, which she occasionally got by stealth. She would drink every thing, not even stopping at brandy. She had nearly all the appetencies of the domestic swine; and the end of her proboscis was essentially a swine's snout. I now beheld the use of this singularly-tipped organ. And an interesting sight it was to see that little thing plough up the greensward with the tip of her nose—and so easily. Here appeared the veritable swinish acuteness of scent for insects and worms, and the swinish facility for rooting in the ground. With surprising rapidity furrow after furrow was made, of about the width of a man's thumb. Whenever a worm or insect was discovered, as when drinking, the nose was curved up, so that the mouth could extract the object from the furrow.

The tail of Nasua is quite suggestive of the raccoon; but Nasua's tail is a much handsomer affair—longer, and with rings more numerous and of gayer colors. With admirable intelligence, our pet put this beautiful appendage to a remarkable use. She was tethered by a string to a chair, and an egg was put on the floor at a tantalizing distance. She could just touch it with a paw, and that touch caused the coveted prize to roll out of reach. She then turned her hind-feet toward it, pulling hard so as to stretch her neck; still even with a hind-foot she could not touch it. The logic of events was now, "Get it if you can!" All this Nasua well understood, for she turned tail on the subject altogether—not, however, as did Reynard on the grapes, but strategically. She gathered herself up, and looked at the coveted object with speculative eyes. Then she swung herself round again, pulling hard on the tether by the neck. She then curved the tip of the tail so as to make a little hook. Now she grasps the base of the tail

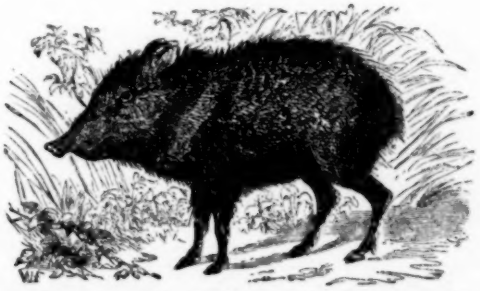
FIG. 4.

*Brown Bear* (Ursus arctos). This cut shows the plantigrade step, in which the entire sole of the foot is put down at once. The same step characterizes the Coati-Mondi and Raccoon. In the Bear this characteristic finds its highest expression.

with one paw, as with a hand, thus stiffening and steadying the organ. She next slowly and cautiously rolled the egg, by the curved tip of the tail, through a section of a circle, until it was brought within reach of one of the front-feet. The egg now seized, sitting on her hind-feet, like a bear, she cracks it, extracts the contents, and neither spills a

drop on the floor, nor so much as soils that wonderful nose; for, among her many gifts, is her soft and extensile tongue. This caudal expedient is sometimes found with the American show-monkey, when a bit of gingerbread is put by the roguish boys at an inconvenient distance; but, as, in such instance, the tail is prehensile, is in fact the monkey's fifth hand, such feat is no great shakes after all, but is quite in keeping with what the organ is cut out for. It is, at most, but little more than that instinct which structural or functional capacity might evolve. But, in Nasua's case, it is animal contrivance, pure and simple. There is, too, a latent fact which peeps out here: for this bending of the caudal tip looks to the faculty possessed by its cousin, the Kinkajou, the extremity of whose tail has a prehensile or grasping faculty of high perfection.

Fig. 5.



*White-lipped Peccary* (Dicotyles labiatus). Snout hog-like, but flexible.

She showed considerable attachment—her preference being the ladies. She would often, when tied up in the kitchen, sit for many minutes, her little black eyes looking wistfully at the door through which the mistress of the house had passed, and all this time crying pitifully. It was a plaintive cry, in the minor key, and yet a little funny, for it greatly resembled the chirping of a cricket, though not quite so shrill, and the intervals between the notes were a little longer. This tiny cry required for every note a muscular exertion, extending far down the sides of the body, which led to the suggestion that "the plaint came from the depths of the heart."

Though at times somewhat irascible, this little animal was very playful with those who could understand and humor her ways. And her method in play was a good deal like that of a dog. She would take my fingers into her mouth, and make believe to bite, and would roll on her back in manifest glee. It required at first some courage to take part in her gambols. On one occasion, thinking that she gave me too hard a nip with her teeth, I returned her a smart slap in the face. This experience was novel and startling, and caused her to open her mouth and chatter as a terrified monkey does. On one occasion she so far forgot herself as to bite me quite severely. It was but one snap

of the mouth—a mere spurt of temper. I gave her such punishment as I considered judicious. For a while she kept up a snapping at me, accompanied by a monkey-like chattering of rage and fear. At last she laid down her head in submission. I then stroked and patted her. It was now all made up, and we were friends again. On this subject

FIG. 6.

*Wild-Boar* (Sus scrofa). In this animal the snout has attained perfection as an organ for upturning the ground, but it has slight flexibility.

of punishment I soon learned an important fact. You might slap and shake this little thing quite severely, when her will was crossed, or a slight fit of temper was upon her, without subduing her. She had, however, a wholesome dread of the rod. A twig not thicker than a straw was sufficient. A blow from this, although it scarcely ruffled the fur, would reduce her to instant and complete submission. The exhibitor of wild animals understands the virtue of his little whip.

The attachment of this interesting animal to her new home was intense. I frequently caused her to be taken to the commons and set at liberty among the trees. Considering that the coati is a thoroughly arboreal animal, and such its agility that it descends trees head first, one would suppose that this would awaken the dormant natural habits; but she would invariably hasten home by the shortest route possible; and, if, on her return, she found the door closed, would sit on the steps and cry.

FIG. 7. *American Tapir* (Tapirus Americanus). The snout of this animal is a proboscis, to some extent prehensile; hence approaching that of the Elephant.

One morning, at an early hour, coati was missed from the kitchen. A search was set up. The ringing voice of our little boy was heard, with the occasional word, "Jack." And so it was—Jack was in bed with the little three-year-old, and they were having a high time together. This trick she played whenever opportunity allowed. Often,

at an early hour before the child was awake, have we found Jack self-ensconced in the arms of his little master. Of course, prudence dictated that this should not be permitted; but Jack would steal upstairs so noiselessly that the thing was often done before we had time to suspect.

FIG. 8.

*Asiatic Elephant* (Elephas Indicus). Here the snout (proboscis) has attained the perfection of flexibility and prehensility.

A word is necessary as to the peculiar temerity of this animal. From two points it was liable to give way to extreme impulsiveness—the excitement of opposition, or of inquisitiveness. If any thing attacked her, whatever the object or the odds might be, she would face the assailant, and close in with her shrill little squeaks of rage, and in a wild sort of dash. If one slapped her, whatever might be her terror, she would rush upon and snap at the hand. The dog-like sagacity of running under the table or chair was not her way. Hers was the peccary instinct of running upon danger. No monkey could be a more importunate or impertinent teaser than was our coati; but Jocko shows sagacity with his jokes—for he always adroitly leaps aside of consequences. I have watched our pet tease the cat with imperturbable persistency, until Tabbie, unable to tolerate matters any longer, has struck her sharp claws into that soft proboscis, then moved away, leav-

ing her persecutor dazed with astonishment. Then, in a moment, forgetting all, she would turn her attention to the setter-dog, and, despite his growls and menacing teeth, would keep up a systematic worrying, catching at his tail, nipping at his legs, and even poking her nose into

FIG. 9.

*Ring-tailed Lemur* (Lemur catta). The Lemurs constitute the lowest family of the Monkeys. A little animal of South America, known as the *Kinkajou*, is, in external aspect and general habit, very like the Lemurs, and yet is placed by systematists close to, and in the same family with, the Coati-Mondi, to whom its plantigrade feet show its near relationship. But this first-cousin of Coati-Mondi is also not unlike the Sapajous, or hijar monkeys, for it has a head like them, and also their accomplishment of a long prehensile tail. (See Fig. 10.) Coati-Mondi has Lemurine traits also.

his ears. At length, the poor brute, fairly goaded into rage, seized her like a rat, and, but for my prompt interference, that would have been the last display of Nasua's rashness. One morning she got into the dining-room as we were at breakfast. She took possession of mad-

am's lap. Her first act was to poke her nose at the coffee-urn. This evoked a squeak of pain. It was supposed that she had had enough. Not quite. Her next essay was on a cup of hot coffee, with a similar result. She now smelt the contents of the sugar-bowl. This discovery so excited that "sweet will" of hers that instant removal became imperative. Later in the day she tried to capture a wasp. She struck it down, and held it a second under her foot. This was met by an appeal addressed solely to her understanding, of so pointed a nature as made her chatter with distress. Disabled in one wing, the insect could not fly away. Although still smarting from the wounded foot, the moral of the lesson is only half learned. Coati cannot give "little yellow-jacket" up. So she tries the wasp again—this time with her nose. Alas, that sting! Miss Nasua now finds that other little folks, besides herself, can utilize their tails; for, in proof of this, she receives

FIG. 10.

*The Sai* (Cebus capucinus). One of the South American Sapajous. The tail prehensile, but probably not more so than that of the Kinkajou, the close ally of Coati-Mondi.

not merely a duplicated, but an intensified experience, such as exacts a staccato outgush of agony, of truly simian expression. We can recall but one lesson which she took sincerely to heart. The old cow was quietly ruminating near the house. With her usual temerity, for she was always ready to "go it blind," Coati made an attempt to climb one of Cushie's legs. The cow raised her foot to shake the annoyance off, and in setting it down she put her hoof on Nasua's tail, and there standing, gravely ruminating, held her fast to the ground. Her rapid, chattering cry brought one of the ladies to her rescue. The tail was very badly hurt. Ever after, between Coati and Cushie, a respectful distance was maintained.

We now call attention to one of the most interesting facts in modern zoology. Agassiz pointed out, with much precision, the ex-

istence in certain animals, both fossil and recent, of two sets of traits —one proper to, and marking their peculiar individuality as members of an order, tribe, or family; and the other set, although found in them, yet destined to a fuller unfolding in animals yet to be created, and to mark their peculiarities. In a word, the species in question was regarded as looking forward to or foreshadowing, in these seemingly eccentric traits, the characteristics of tribes yet to come. As, for example, take the ancient Ganoids, or fishes, covered with shining, bony scales, as the word signifies. Their common representative, now, is the sturgeon, which, though a fish, has structural and physiological points that belong to the reptiles. Regarding these curious traits as put together in one individual, and in a sense to be yet separated from it, and specialized in other and higher animals, Agassiz invented, felicitously, as we think, a term to express these facts, namely, "synthetic type." Dana prefers the phrase "comprehensive type," and Guyot uses the term "undivided type."

The study of this almost grotesque little animal has proved singularly suggestive of certain points of structure and habit, usually regarded as peculiarities of other animals. In Nasua are found features which elsewhere are sufficiently dominant to warrant generic distinction—as the architect can specify certain points in the Composite order which are derived from several other orders. To designate the parts that make up this strange unity in our subject may not be easy. The botanist is, at times, perplexed in his effort to formulate the specific distinctions of a simple plant. Let him take an oak, for example—and it may be that the analysis is unsatisfactory; yet the specific conception of the tree, taken from its contour and entirety, may, for all that, be quite trustworthy. To the writer, the Nasua, viewed as a whole in the matter of structure, form, and habit, has appeared to be a synthetic, or comprehensive type—not, perhaps, a composite, as made up of what had been before, but possibly typical of what was to come. Limited strictly to anatomical analysis, the typical range would be narrowed; but, studied in the above more exhaustive method, the diagnosis must, we think, be highly significant. It may appear a superficial resemblance that is presented in the ornamentation of the respective tails of the coati and the raccoon. But these animals have also anatomical parallels of structure. Both have a similar dental arrangement, and both have plantigrade limbs. Here, again, the coati, with the coon, becomes cousin to the bear, for all three have that structure which compels that setting down at once the entire great sole of the foot, and that walking thereon, which the books denominate plantigrade. The three, also, have similarly-shaped heads, similar small eyes, small, trim ears, and peculiar claws, which are, all and several, known as ursine traits. They have also not unlike appetencies of food. They are plantigrade carnivora, and have in common a striking habit which removes them from the pure or digitigrade car-

nivora, namely, that of raising their food with the paws toward the mouth, and bowing the head to meet it half-way. The coati and raccoon will tear the food into fragments, and sticking into it the claws, like an improvised fork, will thus convey it to the mouth. Who ever saw a dog or cat raise its food from the ground, except by its mouth? Our Nasua, then, has elements of ursine structure, aspect, and habit.

But this little animal has also something of the appetency, structure, and habit of the swine. Look only at the cut of Nasua asleep, and mark the resemblance of the end of its proboscis to the snout of the hog. The engraving is from a photograph, and gives an admirable foreshortening of the organ. We have shown that in function it is identical; for the animal roots precisely as a hog. Here it looks toward the swine through the peccary, that hog-like animal of its own country. We have also noticed that, in a common recklessness, they —the coati and the peccary—bear a psychic similitude. Both have a habit of wildly confronting danger, and both have been known to overcome great perils, and to repulse superior enemies, by actual temerity—real sauciness, or sheer effrontery of dash.

And there is that remarkable proboscis, which actually supplies the generic name—an organ so mobile, and so effective, and so facile of disposition and adjustment. Herein, through the tapir, appears an elephantine expression point of relationship.

Then come those traits so simian—that inappeasable inquisitiveness, and that capacity for quasi-human expedients, and that monkey vice of incessant teasing, and that monkey chattering, expressing terror or distress. It is true that here we seem to stand entirely on metaphysical ground, as we cannot demonstrate any anatomical points of structure related to these traits. And we admit that, in these matters, we have no right to demand conviction unless from logic so formulated. Still the traits are there; and we feel that these traits, physiognomical and psychic, cannot stand unrelated to some important physiological data, which may perhaps place Nasua a little below the Lemurs in rank, through which inchoate monkeys it may look toward the Cebidæ, to its distant relatives, the South American Sapajous. And what striking resemblances to these well-known monkeys are noticeable in the Kinkajou, first cousin of the Coati-Mondi.

We close with a great truth which this little creature unfolds, of surpassing interest. As a synthetic type, this little being is very ancient, even on the geological record. Its lineage goes high up the stream of animal life. The first coati-mondi told off certain points of the great zoological plan yet to be unfolded. It typified the raccoon yet to come, and the peccary, and the swine, and the bear, the tapir, and the elephant; and, as a faint, yet expressive signification, it told, on its psychic side, at least, of the monkey, as the crown of the dumb creation. And by the same record we read the superior antiquity of the so-called New World to the Old: for the ancestors of Nasua were

pursuing their prey in the American woods ere Asia and Europe had risen from their baptism under the sea.

And not zoological only, but may we not read, in this "comprehensive type," a geological prophecy also, that, in the far-off future, our continent shall again sink into the transforming waters, when His behest cometh, who maketh all things new?

## WEATHER PROPHECIES.

THE science of the weather may be said to have sprung up within the last half century, and we must not therefore wonder that, until very recently, meteorological science has rather been concerned with the weather as it has been, than in prophesying what kind of weather may be expected. Indeed, this is almost the case at the present day; for, were it not for the telegraph, storm-signals would be of little avail. Much was gained when, from the conclusions drawn from a large number of observations, a storm could be telegraphed from any place as *coming*, instead of as happened. This stage of the science is perhaps as far as can be usually attained in the present day; in some future time, from the careful study of the laws, it may be possible to predict, with average certainty, the state of the weather from day to day, or even for several days to come. It remains to be seen how far this power has been attained; and it may not be uninteresting to notice, in passing, the very unstable ground upon which weather predictions were founded before meteorology included this second division.

Whether we take as type the old dame's faith in the gambols of her cat, the high flight of some birds and the low flight of others, the "camel" in the clouds, or the chirruping of grasshoppers, we have much the same arbitrary system, or, rather, want of system, although these signs may not be without some definite cause, more or less remotely connected with coming changes in the weather. In many country places it is common to hear it remarked that "the rain will soon clear up, for the birds are singing;" the coming change is perhaps already sensible to their more delicate organization. There is also the appearance of the clouds; and to this indication even the lamented Sir John Herschel attached somewhat of a reliance, in that "anvil-shaped clouds" portended a gale of wind. But, as a rule, the moon may be considered to hold the first place of influence upon weather predictions. Halos round the moon are the phenomena most commonly observed, and are readily explained by the laws of the reflection of light from the particles of aqueous vapor suspended in the atmosphere. When these halos are colored, we may infer the presence of watery particles in the higher regions of the atmosphere; when the

halos are white, we may conclude that the particles are frozen, and expect cold weather. Crossed halos, mock moons, or highly-developed phenomena, indicate larger crystals of ice, and probably frost, hail, snow, or heavy rain, after three or four days, according to the season of the year. Similarly the laws of reflection of light indicate that the cause of a deep-purple morning or evening sky is the large amount of moisture present in the atmosphere. Another effect of the moon, when at the full, is to clear the sky of cloud, traceable, says Sir John Herschel, to a distinct physical cause, the warmth radiated from its highly-heated surface; though, why the effect should not continue for several nights after the full, remains, in the opinion of the same accurate observer, problematic. Other lunar prognostics, founded on arbitrary rules, as to the time of the day or night at which the changes or quarterings take place, are worse than useless, for they are calculated to mislead, and are generally included in almanacs or note-books intended for sale only, being in some cases attributed to an eminent meteorologist or astronomer—Sir W. Herschel or others.

It is of course far from our purpose to enter here into a disquisition on the theory of the trade and anti-trade winds, and their barometrical indications—subjects that can be usefully discussed only in a treatise on meteorology: we limit ourselves to the present position of weather prognostics, although it must be admitted that any advance yet made or likely to be made in prognosticating the weather arises from the study of such recurrent phenomena, the investigation being much aided by the highly-developed character of the laws of the expansion of gases, upon which laws the theory of the wind is founded. Thus we know that a rise in the barometer, together with a fall in temperature, as shown by the thermometer, indicates the approach of a cold, northerly current of air; while a fall of the mercury in the barometer, with a rise of that in the thermometer, indicates that a southerly or warm air-current is on its way. Northerly currents may include winds from the northwest and northeast, as well as from the north; similarly, southerly currents may include winds from the south, southeast, or southwest. When the barometer rises while a northeast wind is blowing, with prevalent hail, rain, or snow, there may be no change. Of barometrical indications alone, it is generally known that a rapid rise portends changeable weather; a slow rise, the contrary; a rapid fall, heavy wind, rain, and snow; while a fluctuating height of the column of mercury indicates unsteady weather. With a heavy gale of wind in the east or southeast, changing south, the barometrical column may fall until the wind shifts its quarter. Upon such observations did Admiral Fitzroy base his code of instructions, now to be found by the side of every barometer, his forecasts depending on the indications of the barometer and thermometer, with observations as to the direction and force of the wind with regard to time and place, and its previous course taken altogether. These indications are thus not

absolute, but relative to the preceding state of the weather. But also these indications are valid for only a short interval before the actual advent of the storm; and in some instances, as in the Hyperborean storm of the 2d and 3d of October, 1860, the interval is too short for any advantage to be taken of the notice. The particulars of this storm, which present in true character the difficulties which the meteorologist must encounter, are too interesting to be omitted, and we shortly recount them from the complete and admirably-conducted investigation published by Prof. C. Piazzi Smyth, in the "Annals of Scottish Meteorology for 1856 to 1871." The term *Hyperborean* has been employed to prevent confusion with tropical hurricanes; it has also been called, from its essential locality, the Edinburgh storm. We have to consider only the practical lessons to be deduced from the observations of this storm; the account of the actual observations must be read from the before-mentioned report of Prof. Piazzi Smyth. First, then, the barometric notice was insufficient and too local to be of service, while the storm was too quick in its movements. St. Hilda is the most westerly station; and, even if the storm could have been telegraphed thence, the message would have allowed only two hours for preparation, and would have arrived while the eastern men were sound asleep. If a message could have been sent from Iceland the day previous to the arrival of the storm, many wrecks would have been prevented. So that we see the present system of meteorology necessitates not only diligent but earnest watching of the signals that should be afforded by a net-work of cables and overland wires, for it is by a series of connected observations, extended over a large area, that the usefulness of this branch of meteorology is alone likely to be advanced.

But, it may be asked, what definitive knowledge can be gained, say not of storms, but of average weather for some future period? Here we must again refer to Prof. Piazzi Smyth's report on the rock-thermometers at the Royal Observatory, Edinburgh, and to the Proceedings of our own Royal Society for the 2d of March, 1870, in which predictions of the weather during the winters of 1871–'72 are attempted. The rock-thermometers have by their readings shown some well-marked supra-annual cycles, the relation of which to the sun-spot cycles will be known to our readers. And on this point it may be stated that the Radcliffe astronomer announces, in his report for 1871, that the *mean* azimuthal direction of the wind at Oxford, rigorously computed from automatic records during the last eight years, varies year by year through a range of 58° on the whole, between maximum and minimum of visible sun-spots, the tendency of the wind to a westward direction increasing with the number of spots, and with such west wind, it is to be presumed, the amount of rain also. "The most striking and positive feature of the whole series of observations," continues Prof. Piazzi Smyth, "is the great heat-wave which occurs every eleven years and a fraction, and nearly coincidently with the beginning of

the *increase* of each sun-spot cycle of the same eleven-year duration. The last observed occurrences of such heat-wave, which is very short-lived, and of a totally different shape from the sun-spot curve, were in 1834.8, 1846.4, 1857.8, and 1868.8; whence, allowing for the greater uncertainty of the earlier observation, we may expect the next occurrence of the phenomenon in or about 1880.0. The next largest feature is the extreme cold close on either side of the great heat-wave: this phenomenon is not quite so certain as the heat-wave, partly on account of the excessive depth and duration of the particular cold-wave which followed the hot season of 1834.8. That exceedingly cold period, lasting as it did through the several successive years 1836, 1837, and 1838, was, however, apparently a rare consequence of an eleven-year minimum, occurring simultaneously with the minimum of a much longer cycle of some forty or more years, and which has not returned within itself since our observations began. Depending, therefore, chiefly on our later observed eleven-year periods, or from 1846.4 to 1857.8, and from the latter up to 1868.8, we may perhaps be justified in concluding that the minimum temperature of the present cold-wave was reached in 1871.1; and the next similar cold-wave will occur in 1878.8." Between the dates of these two cold-waves there are located, according to all the cycles observed, even including that earlier one otherwise exceptional, three moderate and nearly equidistant heat-waves, with their two intervening and very moderate cold-waves, but their characters are quite unimportant. With regard to all the waves, it may be just to state that there has been in observation more uniformity, and will be therefore in prediction more certainty, for their dates than for their intensities.

We have thus very briefly surveyed the position of meteorology, and little remains to be said beyond that the results are highly in favor of the hopes of physicists to render meteorology an exact science. —*Quarterly Journal of Science.*

## A NEW PHASE OF GERMAN THOUGHT.

### HARTMANN'S PHILOSOPHY OF THE UNCONSCIOUS.

TRANSLATED FROM THE FRENCH OF LEON DUMONT, BY A. R. MACDONOUGH, ESQ.

### I.

IN an age like ours, when philosophical criticism, applied to all ideas, has dissipated most of the fictitious charms lent to existence by the imagination of mankind—when the advance of science leads us more and more to look on the world as it is—when, no longer able to find consolation in creeds and myths, we grow more closely and constantly

familiar with inflexible reality, there is no reason for surprise if, in the moment of reaction from the illusions of the past, certain spirits, unable to keep the golden mean, permit themselves to be led captive by exaggerations of quite another kind, and, taking the leap over realism, fall into a pessimism which shows things to them, no longer such as they are, with the impress of facts, hard and brutal enough already, upon them, but even more sad and evil than the reality. But we may well think it strange that such exaggerations, heavy discouragements as they are to humanity, should win their growth and start into theories in the very country of Leibnitz, and of systematic optimism—the country seemingly destined, by the political events of our times, to lead all others in giving brightness and cheer to all judgments of the aspect of the world.

There has arisen in Germany a philosophic school built on the belief that, in existence taken as a whole, evil prevails over good—a school that sighs for the annihilation of being as the sole relief from its miseries. It is one of Cousin's most just remarks that the path of German metaphysics, opened by Kant, must find its logical issue in nihilism. Indeed, the romantic writers, relying on Schelling's half-mystical system, did not hesitate to preach a sort of quietist indolence as the highest aim given to man to reach. Thus Schlegel, with other critics of the same school, was led to envy for man "the divine idleness and happy life of plants and flowers;" and, in his famous work "On the Language and Wisdom of the Indians" (Heidelberg, 1808), to admire the calm and passionless life of Oriental ascetics. Homer, whom romanticism had already sacrificed to Ossian, saw himself ere long dethroned by Buddha. The political events of this lower world had no power to shake souls permeated by so lazy a wisdom. Yet it was the hour of storms raging everywhere—the hour for the crash and downfall of the old Germanic edifice, when Austria and Prussia trembled for their threatened successive overthrow under the blows of Napoleon; but all this mattered little to those mystic spirits who persisted in living in an ideal world, careless of French bayonets, or the embargo, or the Confederation of the Rhine. They averted their looks, especially from those low creatures who struggle on the earth's surface to win their bread, and proclaimed that the perfection of the science of life is to do nothing. It is true these fine theories were put forth in a highly-emphatic style, which provoked Richter's raillery, and gave a flat contradiction to the quietist doctrines they upheld.

In 1819, Schopenhauer's great work appeared, "The World regarded as a Manifestation and a Will." Though this philosopher was an independent thinker, disconnected with any school, he too had yielded to the influence of Eastern studies. "I have been fortunate enough," he said, "to be initiated into the Vedas, access to which was opened to me by the Upanishad's, a great enlargement of my mental vision, for I believe this age is destined to receive from Sanscrit litera-

ture as strong an impulse as the sixteenth century owed to the revival of the Greeks." Foucher de Carcil, who had occasion to visit Schopenhauer, relates that "he had imported at great expense a Buddha, and showed it to his visitors with mischievous pride. He had no patience with English missionaries who undertake to convert their elders in religion." According to Schopenhauer, there is nothing but wretchedness in the world; evil alone is positive; pleasure is a mere negation of pain, and thus has no reality. As to happiness, it is an empty word —progress, a sheer Utopia; history, nothing more than the long-drawn-out torment of humanity's nightmare. What is life? A fabric that is not worth what it costs—an endless hunt in which, sometimes pursuing, sometimes pursued, men fight over the fragments of their slain victims—a war of all against all, *bellum omnium contra omnes*—death discounted, Parmenides called it—and, to sum up all, a sort of natural history of misery, that may be thus rendered in brief: "To wish without a motive; always to suffer; always to strive; and then to die, and so over and over again 'in sæcula sæculorum,' till the crust of our planet scales away into little bits." What are the practical consequences of such teaching? That the mere fact of being born is a misfortune, and that to give life to a new being is a bad action. Hence, this strange analysis of modesty: "See these two beings whose glances seek each other. Why that mystery they shroud themselves in? Why their timid and shamefaced air? Because they are two traitors, who fly to the darkness to perpetuate in another all those tortures and sorrows that would reach a speedy end but for their treachery. And there will always be such criminals, who will ogle and caress after the same fashion, to perpetuate life, to live again in another being." And what is the moral principle of the system? Pity; nothing else than pity. The ascending series of living beings ends with man, because a being superior to man, and more intelligent, would not consent to live and keep up this wretched comedy a single day. The aim of philosophy is to enlighten man as to his deplorable condition—to inspire him with longing to be annihilated, and never again to live after death, under any form whatever, and to unfold to him at length the means of gaining this annihilation. Remark that in all these teachings there is not a trace of sportiveness, none of the ironic sallies of the humorist, the inspiration of a misanthropic fit; temperament has nothing to do in producing them. We are brought face to face with a profoundly and learnedly elaborated system, one that criticism must treat with all gravity. Is this the dawn of a Western Buddhism? Are the European offshoots of the Aryan race, like their brothers of the East, about to aspire to the supreme *Nirvana*, and petrify themselves in asceticism?

It is a fact that Schopenhauer did not remain an isolated phenomenon. The pessimist doctrine gathered a school, and we might name its distinguished disciples—the Frauenstadts, the Gwiners, the Ashers.

The book before us is one full of vigorous discussion, first published in 1869, repeated in the fourth edition already, which has made a powerful impression in Germany, and would assuredly have been heard of in France if the deplorable events of later years had not distracted attention from speculative studies. The book we speak of is the "Philosophy of the Unconscious," by Edward de Hartmann.

Though Hartmann adopts a very different system of metaphysics from Schopenhauer's, he admits having borrowed from that philosopher the point of departure of his system; his moral views are similar, if not identical; he has the same fellow-feeling with Eastern philosophies, the same pessimist color in his view of the world and of existence in general. Besides, Hartmann announces himself as a disciple of Schelling, and thus links himself with the romantic school. Just as he has a strongly-marked leaning toward eclecticism, and fancies he can reconcile the two systems of Hegel and of Schopenhauer, so too he attempts to fuse together optimism and pessimism: but it is for the sake of maintaining that even in the best of possible worlds, which naturally is our own, evil still prevails immeasurably over good. For him, as for Plato, for the old religions, existence is a fall. The human race, like all beings in the universe, is the prey of many miseries while tasting but few joys, and the advance of philosophy consists in gaining an ever-clearer conviction of this sad truth. Meanwhile, man is deluded by instincts that make him cling to life, and urge him to cares for its preservation and reproduction. These instincts are a divine blessing, since they were necessary to keep life going, to make civilization possible, to give man time for climbing toward philosophic intelligence, and in a word to invest triumphant science with the power to unseal his eyes to the wretchedness of his state: man at the outset must needs be sustained by the delusive love of life, that he might some day win the power of willing, not merely his own non-existence, which Schopen hauer contented himself with, but the non-existence of the whole race too, and even, if we clearly take in Hartmann's doctrine, the annihilation of all real being. When sufficiently enlightened, man will acknowledge the vanity of his desires, and let himself die of disgust. If high intellects, great poets, thinkers of genius, are for the most part melancholy, it is because they draw nearer to the truth than the ignorant crowd, ruled wholly by its instincts. The discovery that life is unendurable is pregnant perhaps with awful catastrophes for the future; the masses will grow more and more restive in their misery; formerly they felt little of it except when their stomachs grumbled, but the older the world gets, the more threateningly the spectre of pauperism rises. The social question of our time rests, in the last analysis, only on the stronger sense of their sufferings that has seized the working-classes, although their situation is a golden one compared with what it was two centuries ago, when the social question had no existence. And yet the rich are even more to be pitied than the poor, the educated classes

more than the ignorant, for the same reason that fools are generally happier than people of sense, and the savage happier than the civilized races. Happiness, in fact, is in an inverse ratio to the quantity of existence, and the more developed, the less coarse, a man's nervous system is, the more he suffers; now, the progress of humanity, wealth, culture of mind, multiply man's needs and refine his nervous sensibility. Wretchedness grows, then, with the consciousness of wretchedness. But, thanks to the sovereign wisdom of the unconscious principle that rules the universe, the world will at last arrive, through social cataclysms and by force of that very conviction of its misery, at annihilation, which will be the term of all its woes.

Hartmann seems, therefore, to concede the position to those who argue that religions and creeds in general are all that has made human life endurable and civilization possible. There will be more minds ready to accept his testimony in favor of the usefulness of illusions than there will be to adopt that Utopia of annihilation which in his view must take their place in the future. Three grand illusions have in turn sustained humanity, up to this day: The first, the illusion of childhood and the ancient world, consisted in the dream that happiness might be actually attained by the individual, and during the present life. The second illusion, which replaced this, was the fancy that the individual will attain happiness after his death, in a life transcending the present. The last is the grand modern illusion, that of progress, which teaches that happiness, as it cannot be the individual's aim, either in this life or in another, must be sought for the species in the future of humanity, in the evolution of the world. To all these illusions succeeds the deception of humanity's old age, reaching the term of its development of consciousness, and recognizing at last that happiness is nothing else than the absence of pain, and can only be realized by the annihilation of being.

Hartmann takes care to warn his readers that they deceive themselves if they look for consolation and hope in philosophy. For such objects, books of religion exist. But philosophy pursues truth exclusively, careless whether its acquirement sustains or contradicts the sentiments inspired by the illusions of instinct. Philosophy is hard, cold, insensible as stone. Floating in the ether of pure thought, it gravitates toward the icy knowledge of existence, its causes, and its nature. And if man fails in the moral strength to endure the overwhelming results of his thought, if his heart yields to the spasm of despair, if he gives himself up to desolation, what will philosophy do? Will it revive his courage? No! it will merely note down these facts of despair and desolation as a precious contribution to its materials for physiological observation. And when, on the other hand, meditation upon the truth fills stronger souls with sacred indignation and noble rage, a repressed wrath against this empty masquerade of existence, or if that wrath breaks into bursts of Mephistophelian humor, or pours

its disdainful pity, mingled with irony, upon the unfortunates cheated with the shows of happiness as upon those who yield to despair—when, at last, the soul, bracing its strength to fight this fatality, discerns a plain escape and issue from this hell—these again are but facts which philosophy, still calm and impassive, verifies and records, and its work is done.

We readily admit that there is a grandeur in these ideas of humanity and philosophy. But the critic's duty is, to ascertain whether they are correct, and do not merely create still a new illusion to add to those the world has hitherto been cradled in—one equally empty with the rest, and only perhaps differing from them by the disadvantage of being far less cheerful and helpful to humanity. As it relates to the world's progress, all these systems may be reduced to two classes: on the one side, those which hold up the universe as tending toward a designed aim, and guided by an intelligent principle toward a providential end, such as the realization of happiness for the individual, or a certain perfection of humanity, or, still more generally, some kind of cosmic condition: on the other side must be placed all those systems according to which the world is not moving toward a foreseen and chosen end, and is ruled only by the force of things, intelligence itself, wherever it is manifested, being nothing more than a resultant and a particular phenomenon. According to these latter systems, if humanity and our world were to come to an end, these results would only flow from the necessary relations between the facts of the universe; and these systems, if they are pantheistic ones, can find a very clear expression for their doctrine in the formula that the occurrences of the universe have as their principle not a divine will, but merely the eternal nature of God.

Hartmann, who belongs, at several points, to the traditioned spiritualistic philosophy, displays a strong attachment to the idea of an intelligence presiding over the destiny of the world. Although a pantheist, he continually reasons as a mere deist, a contradiction which seems to us to be the source of most of his errors. His God, who is supremely wise, omniscient, and prescient, but who is not omnipotent, for he had not the power to prevent the production of this evil world, ought *a priori* to govern every thing toward the best end. Now, this end cannot be individual happiness, for the individual dies, and Hartmann does not admit the survival of personality. It cannot be the perfection of the race, for humanity is doomed to perish whenever the burnt-out sun shall cease to furnish its conditions of existence. Must the end proposed by Providence be sought for in the destiny of our world itself? But modern science teaches us that the world also is doomed to inevitable destruction. Thus, from the necessity of rejecting all these positive ends, nothing remained but to seek the solution of the problem in a purely negative end, and this is what Hartmann, following Schopenhauer, has undertaken. The best possible end for

the world is its annihilation, and it is toward this term of all evils that the supreme intelligence is leading us.

To establish the truth of this doctrine, Hartmann has elaborated his theory of the unconscious. Is it science? or is it really nothing else than a metaphysical romance? It is this that we propose in the next part to investigate.

## HOW THE FEELINGS AFFECT THE HAIR.

By DANIEL H. TUKE, M. D.

THE influence of grief or fright in blanching the hair has been generally recognized.

"For deadly fear can Time outgo,
And blanch at once the hair."—MARMION.

It has been a popular rather than a physiological belief that this can occur "in a single night." No one doubts that the hair may turn gray, gradually, from moral causes, and this is sufficient proof of the mind's influence upon the nutrition of the hair. I have known alternations in the color of the hair (brown and gray) corresponding to alternations of sanity and insanity. Some entertain doubts as to sudden blanching of the hair, but I do not believe them well founded, and can vouch for the truth of the following interesting cases·

"Thomas W., about twenty years of age, the son of a milkman, was tall, fleshy, good looking, slightly bronzed, hair intensely black, stiff, wiry, and rather inclined to curl. His general appearance was that of a healthy and well-formed man, used to light work, but much exposure in the open air. In the year 18— one of his thoughtless companions told him (what was not true) that a girl in the town was going before the magistrate on the morrow to swear him father of her child. Poor W. was dumfounded. The announcement had given his whole frame a severe shock; the gall of bitterness had entered his heart, and the mind was under the baneful influence of its power. He hastened home, and sought relief in his bedroom. Sleep was denied him, for his brain was on fire. He saw nothing but disgrace coming from every angle of the room. Such was the mental agitation produced by a silly trick. Early morning brought no relief; he looked careworn, distressed, and his hair was changed from its natural tint to that of a light 'iron-gray color.' This, to him, was a great mystery. In the course of the following day the stupid trick was explained, but the ill effects of it lasted for a long period. Nearly twenty years after, although his health was fair, the mental powers retained signs of the severe shock they had received; his hair was perfectly gray, and a medical friend of mine who met him received the impression that he would carry the marks of this folly to his grave.

"I know of a captain of a vessel, under forty years of age, who suffered shipwreck twice. On the first occasion (in which he lost all hope) his hair quickly turned gray; and on the second, some considerable time afterward, his hair be-

came still further blanched. He resolved never to go to sea again, and kept his resolution.

"A lady, travelling in France subsequently to the Franco-Prussian War, heard of a considerable number of cases of hair blanching (more or less marked) in consequence of fright."

Dr. Laycock, in speaking of pigmentation of the hair, asks whether grayness and baldness are due to loss of tone of the hair-bulbs solely, or are ultimately associated with trophic nervous debility of certain unknown nerve-centres. He points out that the regional sympathy which characterizes trophesies is well marked, and that, as regards baldness, it extends from two points, the forehead and the vertex, ending at a line which, "carried round the head, would touch the occipital ridge posteriorly, and the eyebrows anteriorly." So with the beard, etc. In connection with a succeeding remark, that the eyebrows are a clinical region in brow-ague, herpes, and leprosy, the case already referred to, of a woman who suffered in the night from a severe attack of tic, and found in the morning that the inner half of one eyebrow and the corresponding portion of the eyelashes were perfectly white, may be mentioned. Laycock points out the fact that the hair over the lower jaw is almost always gray earlier than that over the upper jaw, and that tufts on the chin generally turn white first.—(*Op. cit.*, May 13.)

"Mr. Paget, in his 'Lectures on Nutrition,' has recorded the case of a lady with dark-brown hair, subject to nervous headache, who always finds, the morning afterward, patches of her hair white, as if powdered with starch. In a few days it regains its color. Dr. Wilks says he has on more than one occasion had a lady visit him with jet-black hair, and on the morrow, when seen in bed, it had changed to gray. Bichat, opposing the skepticism of Haller, asserted that he had known at least five or six examples in which the hair lost its color in less than a week; and that one of his acquaintance became almost entirely blanched in a single night, on receiving some distressing news. There is no reason to call in question the statement that Marie Antoinette's hair rapidly turned gray in her agony. We have it on the authority of Montesquieu himself that his own hair became gray during the night, in consequence of receiving news of his son which greatly distressed him. Dr. Laudois, of Griefswalde, reported not long ago a case in 'Virchow's Archives,' in which the hair rapidly turned white. But I have not any particulars at hand beyond the fact that, on carefully examining the hair, he found that there was 'an accumulation of *air-globules* in the fibrous substances of the hair.' Erasmus Wilson read a paper at the Royal Society in 1867 on a case of much interest, a *résumé* of which I subjoin in a note."[1]

[1] Every hair of the head was colored alternately brown and white from end to end. The white segments were about half the length of the brown, the two together measuring about one-third of a line. Mr. Wilson suggested the possibility of the brown portion representing the day-growth of the hair, and the white portion the night-growth, and this opinion was corroborated by the remarks of Dr. Sharpey and others of the Fellows who took part in the discussion. Under the microscope, the colors of the hair were reversed, the brown became light and transparent, the white opaque and dark; and it was further

The falling off of the hair is too frequent a result of anxiety, or other depressing emotion, to escape common observation. A case reported in the *Lancet*, of May 4, 1867, forms an excellent illustration:

"A man of nervous temperament began business as a draper in 1859. At that time he was twenty-seven years of age, in good health, though not very robust, unmarried, and had the usual quantity of (dark) hair, whiskers, and beard. For two years he was in a state of *perpetual worry and anxiety of mind*, and his diet was very irregular. Then his hair began to come off. He declares that it literally fell off, so that when he raised his head from his pillow in the morning, the hair left on the pillow formed a kind of cast of that part of his head which rested on it. In a month's time *he had not a single visible hair on any part of his body*—no eyebrows, no eyelashes; even the short hairs of his arms and legs had gone; but on the scalp there could be seen, in a good light, patches of very fine, short down. This was in 1861. Medical treatment proved of no avail, and he was finally advised to do nothing. So long as his anxiety continued, the hair refused to grow, but by the latter part of 1865 his business became established, and, coincidently, his hair reappeared; and when Mr. Churton, of Erith, reported the case, he had a moderately good quantity of hair on the head, very slight whiskers, rather better eyebrows, and the eyelashes pretty good."

The influence of painful emotions in causing gray or white hair and alopecia has been sufficiently illustrated, and it would have been interesting to adduce a reverse series showing the opposite effects of joy. But it is a very different thing to restore to its healthy habit the function of a tissue whose pigment has been removed by slow mal-nutrition, or by sudden shock. I may adduce such a circumstance as the following, however, to show that hair, which has turned gray in the natural course of life, may, by the stimulus of specially-favorable events, become dark and plentiful again:

"An old man (aged seventy-five), a thorough out-and-out radical—even the cancelli of his bones were so impregnated with a thorough disgust of the Government of George IV. that he threw up a lucrative situation in one of the royal yards, and compelled his youngest son to follow his example—insisted that his wife, also aged (about seventy), toothless for years, and her hair as white as the snow on Mont Blanc, should accompany them to the land where God's creatures were permitted to inhale the pure, old, invigorating atmosphere of freedom.

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obvious that the opacity of the white portion was due to a vast accumulation of *air*-globules, packed closely together in the fibrous structure of the hair, as well as in the medulla. There was no absence of pigment, but the accumulation of air-globules veiled the normal color and structure. Mr. Wilson observed that, as the alteration in structure which gave rise to the altered color evidently arose in a very short period, *probably less than a day*, the occurrence of a similar change throughout the entire length of the shaft would explain those remarkable instances, of which so many are on record, of sudden blanching of the hair; and he ventured to suggest that, during the prevalence of a violent nervous shock, the normal fluids of the hair might be drawn inward toward the body, in unison with the generally contracted and collapsed state of the surface, and that the vacuities left by this process of exhaustion might be suddenly filled with atmospheric air.—*Lancet*, April 20, 1867.

About six or seven years after their departure, a friend living in New York gave an excellent account of their proceedings. Not only could the old man puff away in glorious style, and the son do well as a portrait-painter, but old Mrs. —— had cut a new set of teeth, and *her poll was covered with a full crop of dark-brown hair!*"

—*Journal of Mental Science.*

## COTTON FIBRES AND FABRICS.

By Dr. SACC,

PROFESSOR IN THE ACADEMY OF NEUFCHÂTEL.[1]

COTTON owes its kingship quite as much to the tenacity with which its fibres adhere to one another, as to their length or fineness; and were it not that the fibre produced by the *bombax*, or silk-cotton tree, is too smooth, cotton would find in it a powerful rival. Cotton-wool is the downy bed in which the seeds of the cotton-plant are enveloped, and is the product of hot countries. It has several varieties, that cultivated in Algeria and in Southern Europe seldom attaining a height of over twelve inches, while at the equator the plant grows as high as an apple-tree, and bears a fruit twice as large as that of the Algerian species. The cotton grown in the East Indies is of very inferior quality, its fibre being short and hard; yet it was largely used in manufacture, during the war in the United States. Chinese cotton is yellow, and hence the peculiar color of the fabric called nankeen.

The cotton-plant is probably a native of Africa, and Livingstone found it in the interior of that country along the banks of all the rivers. The ancient Egyptians doubtless imported from Abyssinia their cotton cloths for mummy-wrappings and for the garments of priests and nobles, and from them the Jews inherited the employment of that texture for the robes of their priests: for, where the Bible makes mention of *fine linen*, we must read *cotton*, as flax does not grow in hot climates. From Africa cotton-culture passed into Persia and Georgia; then into India, and from India into China. In the latter empire all the clothing of the poorer classes is of cotton, of extremely firm texture. Indeed, so strong is the cotton cloth manufactured by the Chinese, that it is impossible for a man to tear a piece of it across; and the people of China and India refuse to buy European cotton manufactures, calling them mere spiders' webs.

If the true aim of prudent industry be to produce good fabrics at

[1] Translated and abridged from the *Annales du Génie Civil.* Dr. Sacc is the grandson of Dupasquier, who introduced into Switzerland the English process of printing calico. The author is responsible for his own political economy.

the lowest price, then the cotton manufacture is a failure. Instead of even studying to improve the fabric, manufacturers have, ever since the manufacture of carding and spinning machines, thought only of the problem of cheapness. The fabrics they produce are of the worst quality, and quickly wear out; and it may be doubted if there can be found in all Europe, to-day, a single piece of such cotton cloth as used to be manufactured twenty years ago, which gave many times as much wear as the present textures.

The United States annually produce 4,000,000 bales of cotton for the European market, or 1,200,000,000 of pounds, which sells at an average price of one franc per pound. Europe thus pays to the United States 1,200,000,000 of francs every year, simply for cotton, and the 1,200,000,000 pounds of cotton is spun by 50,000,000 of spinning-jennies and wove by 625,000 looms. In the process of manufacture there is a waste of 25 per cent.; hence 1,200,000,000 pounds of raw material give only 900,000,000 pounds of manufactured cotton goods, worth two and one-half francs per pound, being a total of about 2,250,000,000 francs. The process of manufacturing, therefore, does not even double the value of the raw material.

If, now, we estimate the number of workmen engaged in the cotton manufacture from beginning to end, on the basis of six workmen to every 160 spinning-jennies, we shall have 1,875,000 hands so employed. Add to this the number of those employed in raising the cotton-crop, and the crews of the ships which bring it to Europe, and it will be no exaggeration if we estimate the number of employés at 3,000,000, and the amount of capital at 3,000,000,000 francs. No other industry can compare with this for magnitude, and the epithet *King Cotton* is well deserved. If we do not take care, this industry will prove the ruin of Europe, whence it annually drains 1,200,000,000 francs, without making any return. Cotton alone is answerable for the ever-increasing wealth of the United States, and the relative misery of European countries. It is full time to put an end to this state of affairs, by compelling the manufacturers hereafter to produce only firm and durable textures. But, inasmuch as the state can scarcely interfere in such questions, it remains for individuals to apply the remedy. It is in the power of the consumer to apply this remedy, as he alone is accountable for the present painful crisis of the cotton-manufacturing industries of Europe.

We have grown so accustomed to cheap cotton fabrics, that, when prices are advanced, we turn to linen, hempen, or woollen textures, and then the manufacturer is forced to adulterate his products, the consumer shutting his eyes to all defects, provided the article is cheap. It will scarcely be believed, and yet it is the simple truth, that, whereas ten years ago the *piece* of cotton weighed eight pounds, it now weighs but six, or even less, and thus is 25 per cent. less strong than it used to be. But, further, instead of employing good United States cotton,

which is high-priced, the manufacturers make large use now of the wretched cottons of India, which are cheap, but which make a weak texture, mere cobweb. An appearance of firmness is given to these worthless fabrics by a liberal use of sizing, which deceives the eye; but, apply a little lye-water, and the material will be found to be mere lint.

The evil consequences flowing from the false principles which govern the manufacture of cotton are enormous, and it is time to apply a remedy. If Europe goes on thus, ever giving, and receiving from the United States nothing in return, our material prosperity will soon be at an end. The ladies of Austria would appear to stand alone in justly appreciating this danger, and have resolved to eschew cotton fabrics, and use linen in place of muslin. Let Europe follow their example; let muslin be banished from our households, and the immediate result will be, that Europe will stand at the head of civilized nations.

As it is at present carried on, the cotton industry is the opprobrium of humanity and the curse of Europe. Why is it that this manufacture has come to be regarded as a prime necessity of the civilized world? Simply because fashion has backed it, and preached it up: and fashion is a power before which we all bow in submission.

When Indian tapestries and those admirable Mosul textures were first imported into Europe, there arose a universal demand for them, nor could all the looms of the East furnish the supply required. In time the raw material was brought hither, and we spun and wove it by hand; we printed and dyed it. At first no evil consequences flowed from the new industry, because cotton goods, being yet too costly to be used by the poor, were bought only by the rich, who found them really cheap, on account of their great durability. It was only at the beginning of the present century that we first experienced the evils of which we here speak. Then it was that the invention of machinery for the manufacture of the raw material enabled cotton to drive all other textile fabrics out of the market, and forced on Europe the most deplorable of economies.

But our eyes are at last opened to see the calamities which threaten us, and there is now very little danger that this industry will expand any further. It has owed its past prosperity to frauds of the most consummate nature, and now it is undergoing a crisis which cannot fail to turn to the advantage of other textures, and from which it is not likely to recover. We have reason to rejoice at the fall of King Cotton; and now let us keep for Europe all its own resources, by purchasing only fabrics of hemp and flax, wool and silk, instead of muslin; thus shall we give a mighty impetus to home agriculture and home industry.

For certain purposes, however, cotton cloth is indispensable; thus printed fabrics will ever be of cotton, for no other textile fibre takes colors so well. This is due to the fact that cotton-fibre is flat, while

that of flax and hemp is cylindrical; then, too, cotton is more readily bleached than hemp or flax. The manufacture of calico came, as the name implies, from India; and the first printed textures thence brought to Europe were very coarsely printed, with figures in black, red, or blue, the colors being dull, but very fast. Imitation calico was first manufactured at Bordeaux, and from that city the industry passed over into Switzerland and Germany, with the Protestants who were driven from France by the *dragonnades* of Louis XIV. It quickly attained exceptional importance at Neufchâtel and at Mühlhausen, which then belonged to Switzerland; but it is in Alsace that it has made most progress, and taken the lead of all other industries.

Chaptal, the famous Minister of Commerce under Napoleon I., said that the manufacture of calico is the most difficult of industries, for it requires most capital, most patience, the longest training, and the largest amount of good sense and intelligence. Chaptal was in the right; for all the great manufacturers of cotton-prints take rank among men of note. I need only cite a few names. In Switzerland we have our Dupasquiers, Bovets, and Verdans; France has her Haussmanns, Schlumbergers, Koechlins, and Dolfus; and this roll is sufficient to show the justice of Chaptal's assertion. Every year, every day, has witnessed some new improvement in the manufacture of calico; the dull colors of former times have been superseded by a series of novel shades, and coarse patterns have given way before artistic designs which may well compare with the finest designs on paper.

The fixation of colors was the result of chance, aided more or less by the manufacturer's experience, which was not unfrequently nonplussed by a change of the atmosphere, or by a variation in the quality of the drugs employed. In such a state of things, which threatened to ruin the manufacture, recourse was had to science, and the dyers became chemists and physicists. But then the charm was broken: there was no more chance, no more tentative; the fabrication of printed tissues was now a science, and soon, in addition to liquid dyes, we had our dye-stuffs in the shape of vapor, which yield brilliant tints indeed, but not very stable. Finally, besides cotton fabrics, we began to print textures of silk and of wool, or of mixed wool, silk, and cotton, which have given rise to an entirely new class of tissues called *chalys* or barèges, when they contain wool and silk, and cotton warp when they are comprised of cotton and wool.

In order to form some idea of the cotton industry, let us go back to the gathering-in of the crop. The cotton-wool, when it starts from the pod, contains three times its own weight in large oily seeds. These are separated from the cotton by means of machines which are in fact cards, and which seize the cotton, suffering the seeds to drop out. During this process the seeds will be more or less crushed, and give out an oil, which is absorbed by the cotton. If, now, there flows in a current of hot air, the cotton takes fire. This is the cause of the

fires which so frequently break out in cotton-factories, always originating in the rooms where the raw material is set to dry. The minute quantity of oil contained in raw cotton is also the reason of its turning yellow in store, though it was white when gathered in. The fabric has, therefore, to be lixiviated and bleached before being printed. The process of bleaching begins by washing the cotton in lime-water, after which the fabric is passed through a weak acid solution, in order to remove the lime, which else would burn the tissue. It is then thoroughly washed, treated anew with soda, then with a soap of colophony, and finally passed through water.

The cloth is then free from oily matter, but not yet bleached, and it must yet pass through a solution of chloride of lime, and then through another solution of hydrochloric acid. These last two operations take but a moment, and they constitute the very crisis of the process; for, if the solutions be too strong, the tissues are burnt, and considerably weakened, a thing of very frequent occurrence. Formerly, the cloth used to be bleached in the sun; but this tedious and costly process, where the present one requires only a few days, took up weeks, and yet did not bleach the fabric so thoroughly.

Next the white cloth is sent to the printer, who gives it the figures desired. At first plates of wood with the figures in relief were employed in the printing; this was the infancy of the art. Later, plates of copper were used, having the figures cut into their surface; this was a step in advance. Finally the English, whose industrial genius is most fruitful of useful applications, originated the idea of printing with copper cylinders, beneath which the cloth would pass, receiving impressions *ad infinitum*.

Dupasquier introduced from England into the Continent this beautiful invention, which is even yet in process of improvement. From that moment printed cottons grew ever cheaper, although the printing was executed far better than formerly; and the fall in prices became simply enormous when machinery took the place of human hands. Then calico came into universal use, without, however, superseding textures of hemp and flax, which were still employed for table and body linen; it was only at a later day, and when prices were still further reduced, that the less opulent classes began to wear muslin instead of linen. This example was soon followed by the wealthy classes, who little suspected the snare that they were walking into, nor understood that, in substituting cotton for flax and hemp, they were selling out to America one of our most abundant sources of wealth, and of agricultural and industrial prosperity.

Such was the state of the textile market in Europe, when the United States war broke out; a war brought about by Palmerston, who wished England to receive the 1,200,000,000 francs annually paid by Europe for cotton. We know too well how far he was successful in his hateful design; for, ever since that time the East Indies share

with the United States in the privilege of carrying off our millions, under the pretext of selling us cotton. Never was there a more perfect act of piracy; never was piracy better organized than this, or more kindly received, to our shame be it said.

As now the price of cotton was increased, muslin was rejected, and fabrics of hemp and flax used instead; for the latter textures could be had for the same price as cotton goods, while they were of far better quality. Then it was that certain ingenious swindlers conceived the idea of weaving the threads wider apart, so as to yield an increase of 25 per cent. of cloth, with the same amount of cotton; and, to conceal this base fraud, recourse was had to a paste of starch, soap, and pipe-clay, stopping up thus the interstices, and giving the article the appearance of a first-class fabric.

This abominable invention once introduced, cotton fabrics fell to their former price, and found a market. During the ten years which have passed away since public credulity was first duped in this way, every one has to his cost learned of the trick. Hence I suppose I am addressing an audience already convinced; and I repeat again my advice, Buy only linen.

Textures intended for printing were deteriorated in the same proportion, and hence it became very difficult to print or to wash them, and they had to be heavily starched in order to find purchasers, so flimsy were they. But people soon quit using them, and bought mixed textures of wool and cotton, or wool and linen, which came into fashion, and which gave such satisfaction that they will not again be laid aside.

We now come to speak of the lighter tissues—the finest grades of muslin, jaconets, and organdies.

All these tissues are very costly, because they require cotton of the best quality, and it is upon these that the manufacturer of printed goods displays all his artistic skill—all the magic of design. He stops at nothing, for these brilliant artistic effects give him a reputation, and serve as a letter of introduction for his products. I have seen as many as thirty-five different colors, or shades of color, in the large bouquets printed on certain fabrics. But, like natural flowers, these printed flowers quickly fade.

Only the very costliest of textures are now printed by hand—that process being so tedious and so difficult that but few workmen are qualified to perform it. The printing, therefore, is usually done by means of a roller of copper or brass. This roller has the figures cut into its surface either directly by the burin, or by an acid; or, as is more usual, it gets the required impress from the *molette*. Engraving with the burin being very costly, it is employed only in the manufacture of the very choicest fabrics. Engraving with acid is done as follows: The roller is first coated with asphaltum, and on this is counter-drawn with the burin the figure required. The burin may be worked

by hand, or may be guided by means of a pantograph. The figure having been thus traced on the roller, the latter is plunged into a bath of nitric acid, which cuts into the metal at all points where the asphalt coating has been displaced. Finally, the asphalt is washed off with essence of turpentine.

But the figures are usually produced on the roller by means of the *molette*. This is a small cylinder of steel, into the surface of which the engraver first cuts the design. This cylinder then gives to another an impress in relief; and, finally, from this latter a concave impress is taken on the large copper roller of the printing-press. It is plain that as many rollers will be required as there are colors to print; and, owing to the difficulty of preventing the colors running into one another, not more than four are commonly employed—black, red, rose, and violet; or black, brown, red, and cashew. In twelve hours, 100 to 120 pieces, of 50 yards each, may be printed in one color, though not more than 60 to 80 could be printed in four.

The capital employed in the manufacture of printed goods of mixed fibre is enormous, and yields a large return. This manufacture gives also good remuneration to the operatives, and there is every reason why it should be as zealously fostered as the manufacture and employment of muslins and calicoes are to be discouraged, as tending to draw off to America all the wealth of Europe.

## THE PHYSIOLOGICAL POSITION OF TOBACCO.

By W. E. A. AXON, M.R.S.L.

IN speaking of the physiological position of tobacco, we have to deal with the action of the essential principles of that plant upon the human system. The peculiar effects of tobacco are due to the action of the essential oil of tobacco in the case of chewing and snuffing, and to that combined with the empyreumatic oil in smoking. Nicotine, as this essential principle is called, is so deadly an alkaloid, that the amount of it contained in one cigar, if extracted and administered in a pure state, would suffice to kill two men. According to the experiments of Vohl and Eulenberg, the nicotine is decomposed, in the process of smoking, into pyridine, picoline, and other poisonous alkaloids, which can also be obtained in varying quantities by the destructive distillation of other vegetable substances.

Nicotine, as for convenience we may continue to call the poisonous principles of tobacco, can enter the body through various channels—by the stomach, by the lungs, by subcutaneous injection, and by the skin itself. But, in whatever manner it enters the human system, its effects are, in the main, uniform.

The most immediately noticeable symptom following smoking is the

undue acceleration of the laboring forces of the heart. Under the stimulus of tobacco the heart beats more quickly, as is evidenced by the rising pulse. We have not the mass of detailed evidence as to this fact which exists in relation to alcohol, but the experiments made by Dr. Edward Smith, and related to the British Association in 1864, are full of interest. "The experiments were made at 10 P.M., when the rate of pulsation naturally declines (as he had proved by hourly experiments published in his work on the 'Cyclical Changes of the Human System'), and at least four hours after any fluid or solid food had been taken. They were made in the sitting posture, after it had been maintained fifteen minutes, and with the most absolute quietude of body and mind; and thus all influences were eliminated but those due to the tobacco. The rate of the pulsation was taken every minute for a period beginning two or three minutes before the smoking began, and continuing during twenty minutes, or until the pipe was exhausted.

The following are the chief results obtained:

EXPERIMENT 1.

Pulsation before smoking was 74½ per minute.

Smoking 6 minutes—79, 77, 80, 78, 78, 77 per minute=78.1 average.

Smoking 7 minutes—83, 87, 88, 94, 98, 102, 102 per minute = 93.4 average.

Smoking 8 minutes—105, 105, 104, 105, 105, 107, 107, 110 per minute = 106 average.

After smoking 11 minutes—112, 108, 107, 101, 101, 100, 100, 100, 100, 98, and 91.

There was thus a maximum increase of 37½ pulsations per minute.

EXPERIMENT 2.

(Smoking through camphor julep in a hookah.)

Pulsation before smoking, 79½ per minute.

Smoking 6 minutes—81, 81, 81, 83, 82, 82 per minute = 81.6 average.

Smoking 17 minutes—85, 89, 89, 93, 96, 90, 94, 94, 93, 92, 95, 95, 95 96, 94, 97, 93 = 93.

The maximum increase was 17½ pulsations per minute.

EXPERIMENT 3.

(Smoking an empty pipe.)

Pulsation before smoking, 78 pulsations per minute.

Smoking 11 minutes—76, 78, 77, 76, 79, 79, 80, 80, 79, 78, and 79.

There was no increase in the rate of pulsations from the effort of smoking, or from its interference with the respiration.

EXPERIMENT 4.

(To ascertain if, after smoking 6 minutes, during which the effect is very small, and then ceasing smoking, any increase in the effect would follow.)

Pulsation before smoking, 75 pulsations per minute.
Smoking 6 minutes—76, 75, 79, 79, 76, 78.
Smoking 1 minute—82. Cease smoking.
Smoking 10 minutes—81, 88, 83, 82, 84, 83, 83, 80, 82.

The rate of pulsations was maintained, but was not materially increased.

EXPERIMENT 5.

(To prove if the rapidity of smoking causes a variation in increase of pulsation.)

*a.* Greater volume of smoke.

Pulsation before smoking, 70½ per minute.
Smoking 6 minutes—68, 70, 71, 70, 72, 74 = 70.8 average.
Smoking 6 minutes—76, 77, 86, 89, 91, 94 = 85.5 average.
Smoking 4 minutes—98, 95, 96, 95 = 96.0 average.

The maximum effect was thus 27½ pulsations per minute.

*b.* Smoking faster.

Pulsation of the last minute in the previous part of this experiment, viz., 95 per minute—smoking 3 minutes, 94, 49, 96.

*c.* The pipe recharged.

Smoking 5 minutes—87, 93, 96, 96, 96.

There was, therefore, a large effect upon the pulsation, but probably not more than would have occurred with ordinary smoking.

Numerous other experiments were made with tobaccos of different reputed strengths and upon different persons, and the author gave minute directions as to the proper method of making such inquiries."

The heart, then, during the act of smoking, was doing extra work; in some of the experiments this additional labor amounting to more than 50 per cent.

The effect upon the heart is not caused by direct action upon that organ, but by paralyzing the minute vessels which form the batteries of the nervous system. Thus paralyzed, they can no longer offer effectual resistance, and the heart, freed from their control, increases the rapidity of its strokes, expanding the vessels, with an apparent accession, but real waste of force.

Its effect in lowering the animal temperature is very striking. When the walls of the blood-vessels are distended with that fluid, the increase in volume decreases the rapidity of the circulation and augments the local warmth. When the walls partially collapse, the circulation becomes quicker, but the heat diminishes. The heat, in fact, is transformed into motion.

The action of nicotine upon the iris is well known, yet, while some consider it to produce dilatation, others affirm its effect to be contraction. The iris is composed of two orders of muscular tissue. The circular fibres influenced by the *motor oculi*, and the radiating fibres obeying the great sympathetic, perform the two functions of the iris,

dilatation and contraction. The stimulation of the third pair of nerves causes a contraction of the pupil; a larger dose of nicotine destroys its susceptibility and dilatation follows, the upper lid falls, strabismus ensues, the eyeball becomes fixed—in short, the motor power of the eye is paralyzed. M. Blatin considers that the muscular fibre of the eye is not at all affected by the poison.

Blatin proposes to divide tobacco-poisoning into two classes, acute and chronic. The first is the result of a large or unaccustomed dose; the second, the accumulative consequences of doses, perhaps small, but continually repeated.

The unpleasant experiences of the first pipe will enable most smokers to understand the nature of this acute poisoning. Children have even been made ill by sucking at pipes, empty, but already coated with tobacco-juice. Sometimes a very slight dose exercises a fatal effect upon systems in which tolerance has not been established. Thus a youth of fourteen, having smoked fifteen cents' worth of tobacco as a remedy for toothache, fell down senseless and died the same evening.[1] Blatin also tells us of a medical student, aged twenty-two, who, after smoking a single pipe, fell into a frightful state—the heart became nearly motionless, the chest constricted, his breathing was extremely painful, the limbs contracted, the pupils insensible to light, one dilated, the other contracted. These symptoms gradually lessened, but did not disappear until four days after.[2]

But it is chronic nicotism which has the greatest interest for us. The poisonous effects of tobacco in larger doses are too evident for denial, and need scarcely be insisted upon. Far more important is it to learn whether tobacco, in the quantities daily consumed by its habitual users, has a permanently injurious effect upon the human system.

It is often only after a number of years that nicotic symptoms appear, as though the poison acted by a process of accumulation, until the system was charged to satiety. And thus any thing which disturbs the equilibrium of the functions, and so diminishes the elimination of the poison, may give rise to morbid phenomena.

There is a theory not unknown, even among medical men, that the toxic influences of tobacco are only transitory, and that all the poison is ultimately expelled from the system. But it is certain, from an experiment of M. Morin,[3] that the nicotine can be detected in the tissues of the lungs and liver after death.

M. Blatin regards the various local affections as trifling, when compared with the gradual saturation of the system with nicotine, which, accumulating in the tissues, waits for the opportunity, varying, according to individual habits and constitution, of declaring its poisonous nature.

The trembling, which is one of the usual symptoms of acute, is

[1] Druhen, p. 44. [2] Blatin, p. 76.

[3] Year Book of Medicine (New Sydenham Society), 1861, p. 447, and Blatin, p. 93.

also a common result of chronic, nicotism. A very distinguished Parisian physician had hands which shook so much that he could not write. Whenever he remained without tobacco for any length of time, these tremblings disappeared. Another case mentioned by Blatin is noteworthy. A man of forty-five years consulted him respecting violent and numerous attacks of vertigo. When he felt one of them approaching, he was obliged to lie down wherever he might be, in order to avoid falling. In the country, where he had plenty of exercise, they were less frequent than in the town, where his occupation was sedentary. Cessation from tobacco and a tonic regimen quickly restored him.

A physician of fifty-two was afflicted with similar disagreeable symptoms, and was also cured by abstinence. Habit had become so strong that he could not resist at times the temptation to slight indulgence. Finding that these returns to tobacco were immediately followed by his old painful attacks, he renounced it forever.

The circulatory system presents in chronic nicotism similar symptoms to those found in acute poisoning. The most noticeable of these is the intermittent pulse, of which many cases have been collected by Decaisne and others.

Decaisne speaks of narcotism of the heart, but Blatin does not consider the action to be directly upon that organ, but considers the effects described to result from an irregular relaxation of the ganglia of the great sympathetic nerve.

When a person suffering from intermittent pulse was carefully examined, Blatin found the stoppage in the heart's beat followed a series of apparently normal movements. The systole and diastole succeeded in due regularity, and nothing in the play of the central organ indicated trouble, when the heart suddenly stopped in diastole, sometimes for the space of three arterial pulsations. When it awakens from this syncope its action is abnormally quick, as if it wished to make up for the lost time, and force the mass of blood across the organs at one stroke. But, with force insufficient for this purpose, it is exhausted in fruitless efforts, hesitates, wavers, acquires fresh power, commences again, now violent, now feeble, and fulfils very imperfectly the duties which it should perform. Gradually it calms; a foreign element seems to appease the tumult, the heart again becomes regular. The explanation appears to be that the irritation of the sympathetic nerve stops short the movements of the heart, and thus causes the intermittence; then the susceptibility of the nerve is lessened or paralyzed, and the cardiac functions are left to the sole direction of the auto-motor ganglia; hence the disordered beats, which decrease as the nervous force coming afresh from the pneumogastric moderates and regularizes it.

From intermittent pulse to angina pectoris the distance is not far. That tobacco may produce all the usual symptoms of that painful disease has been abundantly shown by Beau. To the cases which he has

cited may be added an epidemic of this nature noted by M. Gelineau, with which a great part of the crew of the Embuscade were struck. The patients were all great smokers. It is worthy of notice that this disease is much more common among men than women.

Difficulty of breathing approaching asthma has also been recorded. Blatin gives a case of a young officer whose asthma could be attributed to no other cause, and who was cured by a simple abstinence and tonic medicines.[1]

Tobacco, acting upon the cardiac and pulmonary branches of the pneumogastric, is not likely to leave untouched its gastric terminations. In an animal under the influence of small doses of nicotine the gastric juice is secreted with increased rapidity, and the action of the walls of the stomach is more noticeable. With strong doses or long-continued usage this secretion is very considerably diminished, and the peristaltic motion enfeebled. That is to say, the tobacco acts upon the pneumogastric, excites it in small, and paralyzes it in large, doses. The smoker takes his after-dinner pipe or cigar to aid digestion. Undoubtedly, it excites the par vagum, increases the gastric secretion, and accelerates the peristaltic motion. Undoubtedly, also, this daily stimulation enfeebles the nerve, and digestion becomes more difficult. The swing back from the excitement causes a reaction, which only an increase in the doses can overcome. The nerve is partially paralyzed. The appetite fails, nutrition is impeded, dyspepsia reigns conqueror.

A military man of thirty-seven years fell into a consumption without any other affection antecedent or concomitant than distaste for food, and salivation. Dr. Roques, after various essays, learned that he was a great user of tobacco, which had led to a sort of chronic fluxion of the salivary glands, and an almost total cessation of the digestive functions, and consequently caused the feeble and consumptive state into which he had fallen. Gradual diminution and ultimate abandonment of tobacco led to a cure in about three months.[2]

The influence of tobacco upon vision is well known. One of the symptoms produced in acute nicotism is blindness, and chronic nicotism gives rise to similar affections. Thus Mackenzie found that patients afflicted with amaurosis were mostly lovers of tobacco in some form. Sichel found cases of complete amaurosis, which, incurable by other means, were easily conquered by cessation from the weed. Hutchinson found, out of thirty-seven patients, twenty-three were inveterate smokers. The observations of Wordsworth and others have so clearly established the fact that the continued excitement of the optic nerve by tobacco sometimes produces amaurosis, that it is now generally cited in text-books as one of the causes of that disease.

We have completed our brief examination of the physiological ac-

[1] Blatin, p. 159, from l'Abeille Méd., t. iii., 1846.

[2] Ibid., p. 265, from Mémoire de Med., et de Chir. Prat., t. v.

tion of tobacco, but in concluding it may be well to point to some portions of the evidence which are especially noteworthy.

The fact that tobacco reduces the animal temperature is an important one. It shows the fallacy of those who smoke to keep the cold out, and proves conclusively that tobacco is neither a generator nor conserver of vital heat, but, on the contrary, a wasteful destroyer of it.

The influence of tobacco, in liberating the heart from those restraints which regulate its healthy action, naturally leads to the conclusion that in frequent doses that organ must, sooner or later, undergo a structural transformation. Although when thus excited it has less pressure to overcome than when in a normal condition, yet the extra exertion cannot but be evil in its results, since it causes an irregularity in the supply of blood, and thus degrades tissue.

Tobacco belongs to the class of narcotic and exciting substances, and has no food-value. Stimulation means abstracted, not added, force. It involves the narcotic *paralysis* of a portion of the functions, the activity of which is essential to healthy life.

It will be said that tobacco soothes and cheers the weary toiler, and solaces the overworked brain. Such may be its momentary effects, but the *sequelæ* cannot be ignored. All such expedients are fallacious. When a certain amount of brain-work or hand-work has been performed, Nature must have space in which to recuperate, and all devices for escaping from this necessity will fail. It is bad policy to set the house on fire to warm our hands by the blaze. Let it, then, be clearly understood that the temporary excitement produced by tobacco is gained by the destruction of vital force, and that it contains absolutely nothing which can be of use to the tissues of the body.

Tobacco adds no potential strength to the human frame. It may spur a weary brain or feeble arm to undue exertion for a short time, but its work is destructive, not constructive. It cannot add one molecule to the plasm out of which our bodies are daily built up. On the contrary, it exerts upon it a most deleterious influence. It does not supply, but diminishes, vital force.

It has been denied that tobacco leads to organic disease, but the evidence is very strong the other way, and it would be very remarkable if continued functional derangement did not ultimately lead to chronic derangement of the organs; that it causes functional disturbance no one dreams of denying; indeed, it has been remarked that no habitual smoker can be truly said to have a day's perfect health.—*Abstract from the Quarterly Journal of Science.*

# AIMS AND INSTRUMENTS OF SCIENTIFIC THOUGHT.

By Professor W. KINGDON CLIFFORD,
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II.

I WANT, in the next place, to consider what we mean when we say that the uniformity which we have observed in the course of events is *reasonable* as well as exact.

No doubt the first form of this idea was suggested by the marvellous adaptation of certain natural structures to special functions. The first impression of those who studied comparative anatomy was, that every part of the animal frame was fitted with extraordinary completeness for the work that it had to do. I say extraordinary, because at the time the most familiar examples of this adaptation were manufactures produced by human ingenuity; and the completeness and minuteness of natural adaptations were seen to be far in advance of these. The mechanism of limbs and joints was seen to be adapted, far better than any existing iron-work, to those motions and combinations of motion which were most useful to the particular organism. The beautiful and complicated apparatus of sensation caught up indications from the surrounding medium, sorted them, analyzed them, and transmitted the results to the brain in a manner with which, at the time I am speaking of, no artificial contrivance could compete. Hence the belief grew among physiologists that every structure which they found must have its function and subserve some useful purpose; a belief which was not without its foundation in fact, and which certainly (as Dr. Whewell remarks) has done admirable service in promoting the growth of physiology. Like all beliefs, found successful in one subject, it was carried over into another, of which a notable example is given in the speculations of Count Rumford about the physical properties of water, to which the President has already called your attention. Pure water attains its greatest density at a temperature of about 39½° Fahr.; it expands and becomes lighter whether it is cooled or heated, so as to alter that temperature. Hence it was concluded that water in this state must be at the bottom of the sea, and that by such means the sea was kept from freezing all through; as it was supposed must happen if the greatest density had been that of ice. Here, then, was a substance whose properties were eminently adapted to secure an end essential to the maintenance of life upon the earth. In short, men came to the conclusion that the order of Nature was reasonable in the sense that every thing was adapted to some good end.

Further consideration, however, has led men out of that conclusion in two different ways: First, it was seen that the facts of the case

had been wrongly stated. Cases were found of wonderfully complicated structures that served no purpose at all; like the teeth of that whale of which you heard in Section D the other day, or of the Dugong, which has a horny palate covering them all up and used instead of them; like the eyes of the unborn mole, that are never used, though perfect as those of a mouse until the skull-opening closes up, cutting them off from the brain, when they dry up and become incapable of use; like the outsides of your own ears, which are absolutely of no use to you. And when human contrivances were more advanced it became clear that the natural adaptations were subject to criticism. The eye, regarded as an optical instrument of human manufacture, was thus described by Helmholtz—the physiologist who learned physics for the sake of his physiology, and mathematics for the sake of his physics, and is now in the first rank of all three. He said, "If an optician sent me that as an instrument, I should send it back to him with grave reproaches for the carelessness of his work, and demand the return of my money."

The extensions of the doctrine into physics were found to be still more at fault. That remarkable property of pure water, which was to have kept the sea from freezing, does not belong to salt-water, of which the sea itself is composed. It was found, in fact, that the idea of a reasonable adaptation of means to ends, useful as it had been in its proper sphere, could yet not be called universal, or applied to the order of Nature as a whole.

Secondly, this idea has given way because it has been superseded by a higher and more general idea of what is reasonable, which has the advantage of being applicable to a large portion of physical phenomena besides. Both the adaptation and the non-adaptation which occur in organic structures have been *explained*. The scientific thought of Dr. Darwin, of Mr. Herbert Spencer, and of Mr. Wallace, has described that hitherto unknown process of adaptation as consisting of perfectly well-known and familiar processes. There are two kinds of these: the direct processes, in which the physical changes required to produce a structure are worked out by the very actions for which that structure becomes adapted—as the backbone or notocord has been modified from generation to generation, by the bendings which it has undergone; and the indirect processes, included under the head of Natural Selection—the reproduction of children slightly different from their parents, and the survival of those which are best fitted to hold their own in the struggle for existence. Naturalists might give you some idea of the rate at which we are getting explanations of the evolution of all parts of animals and plants—the growth of the skeleton, the nervous system and its mind, of leaf and flower. But what, then, do we mean by *explanation?*

We were considering just now an explanation of a law of gases—the law according to which pressure increases in the same proportion

in which volume diminishes. The explanation consisted in supposing that a gas is made up of a vast number of minute particles always flying about and striking against one another, and then showing that the rate of impact of such a crowd of particles on the sides of the vessel containing them would vary exactly as the pressure is found to vary. Suppose the vessel to have parallel sides, and that there is only one particle rushing backward and forward between them; then it is clear that if we bring the sides together to half the distance, the particle will hit each of them twice as often, or the pressure will be doubled. Now, it turns out that this would be just as true for millions of particles as for one, and when they are flying in all directions instead of only in one direction and its opposite; provided only that they interfere with each other's motion. Observe, now: it is a perfectly well-known and familiar thing that a body should strike against an opposing surface and bound off again; and it is a mere every-day occurrence that what has only half so far to go should be back in half the time; but that pressure should be strictly proportional to density is a comparatively strange, unfamiliar phenomenon. The explanation describes the unknown and unfamiliar as being made up of the known and the familiar; and this, it seems to me, is the true meaning of explanation.[1]

Here is another instance: If small pieces of camphor are dropped into water, they will begin to spin round and swim about in a most marvellous way. Mr. Tomlinson gave, I believe, the explanation of this. We must observe, to begin with, that every liquid has a skin which holds it; you can see that to be true in the case of a drop, which looks as if it were held in a bag. But the tension of this skin is greater in some liquids than in others; and it is greater in camphor-and-water than in pure water. When the camphor is dropped into water, it begins to dissolve and get surrounded with camphor-and-water instead of water. If the fragment of camphor were exactly symmetrical, nothing more would happen; the tension would be greater in its immediate neighborhood, but no motion would follow. The camphor, however, is irregular in shape; it dissolves more on one side than the other; and consequently gets pulled about, because the tension of the skin is greater where the camphor is most dissolved. Now, it is probable that this is not nearly so satisfactory an explanation to you as it was to me when I was first told of it; and for this reason: By that time I was already perfectly familiar with the notion of a skin upon the surface of liquids, and I had been taught by means of it to work out problems in capillarity. The explanation was therefore a description of the unknown phenomenon which I did not

[1] This view differs from those of Mr. J. S. Mill and Mr. Herbert Spencer, in requiring every explanation to contain an addition to our knowledge about the thing explained. Both those writers regard subsumption under a general law as a species of explanation. *See* also Ferrier's "Remains," vol. ii., p. 436.

know how to deal with as made up of known phenomena which I did know how to deal with. But to many of you possibly the liquid skin may seem quite as strange and unaccountable as the motion of camphor on water.

And this brings me to consider the source of the pleasure we derive from an explanation. By known and familiar I mean that which we know how to deal with, either by action in the ordinary sense, or by active thought. When, therefore, that which we do not know how to deal with is described as made up of things that we do know how to deal with, we have that sense of increased power which is the basis of all higher pleasures. Of course, we may afterward by association come to take pleasure in explanation for its own sake. Are we, then, to say that the observed order of events is reasonable, in the sense that all of it admits of explanation? That a process may be capable of explanation, it must break up into simpler constituents which are already familiar to us. Now, first, the process may itself be simple, and not break up; secondly, it may break up into elements which are as unfamiliar and impracticable as the original process.

It is an explanation of the moon's motion to say that she is a falling body, only she is going so fast and is so far off that she falls quite round to the other side of the earth, instead of hitting it; and so goes on forever. But it is no explanation to say that a body falls because of gravitation. That means that the motion of the body may be resolved into a motion of every one of its particles toward every one of the particles of the earth, with an acceleration inversely as the square of the distance between them. But this attraction of two particles must always, I think, be less familiar than the original falling body, however early the children of the future begin to read their Newton. Can the attraction itself be explained? Le Sage said that there is an everlasting hail of innumerable small ether-particles from all sides, and that the two material particles shield each other from this, and so get pushed together. This is an explanation; it may or may not be a true one. The attraction may be an ultimate simple fact; or it may be made up of simpler facts utterly unlike any thing that we know at present; and in either of these cases there is no explanation. We have no right to conclude, then, that the order of events is always capable of being explained.

There is yet another way in which it is said that Nature is reasonable; namely, inasmuch as every effect has a cause. What do we mean by this?

In asking this question we have entered upon an appalling task. The word represented by "cause" has sixty-four meanings in Plato, and forty-eight in Aristotle. These were men who liked to know as near as might be what they meant; but how many meanings it has had, in the writings of the myriads of people who have not tried to know what they meant by it, will, I hope, never be counted. It would

not only be the height of presumption in me to attempt to fix the meaning of a word which has been used by so grave authority in so many and various senses; but it would seem a thankless task to do that once more which has been done so often at sundry times and in divers manners before. And yet without this we cannot determine what we mean by saying that the order of Nature is reasonable. I shall evade the difficulty by telling you Mr. Grote's opinion.[1] You come to a scarecrow and ask, "What is the cause of this?" You find that a man made it to frighten the birds. You go away and say to yourself: "Every thing resembles this scarecrow. Every thing has a purpose." And from that day the word "cause" means for you what Aristotle meant by "final cause." Or you go into a hair-dresser's shop, and wonder what turns the wheel to which the rotatory brush is attached. On investigating other parts of the premises, you find a man working away at a handle. Then you go away and say: "Every thing is like that wheel. If I investigated enough I should always find a man at a handle." And the man at the handle, or whatever corresponds to him, is henceforth known to you as "cause."

And so generally. When you have made out any sequence of events to your entire satisfaction, so that you know all about it, the laws involved being so familiar that you seem to see how the beginning must have been followed by the end, then you apply that as a simile to all other events whatever, and your idea of cause is determined by it. Only when a case arises, as it always must, to which the simile will not apply, you do not confess to yourself that it was only a simile and need not apply to every thing, but you say, "The cause of that event is a mystery which must remain forever unknown to me." On equally just grounds, the nervous system of my umbrella is a mystery which must remain forever unknown to me. My umbrella has no nervous system; and the event to which your simile did not apply has no cause in your sense of the word. When we say, then, that every effect has a cause, we mean that every event is connected with something in a way that might make somebody call that the cause of it. But I, at least, have never yet seen any single meaning of the word that could be fairly applied to the *whole* order of Nature.

From this remark I cannot even except an attempt recently made by Mr. Bain to give the word a universal meaning, though I desire to speak of that attempt with the greatest respect. Mr. Bain[2] wishes to make the word "cause" hang on in some way to what we call the law of energy; but, though I speak with great diffidence, I do think a careful consideration will show that the introduction of this word "cause" can only bring confusion into a matter which is distinct and clear enough to those who have taken the trouble to understand what energy means. It would be impossible to explain that this evening; but I may mention that "energy" is a technical term out of mathe

[1] Plato, vol. ii. (Phædon).

[2] "Inductive Logic," chap. iv.

matical physics, which requires of most men a good deal of careful study to understand it accurately.

Let us pass on to consider, with all the reverence which it demands, another opinion, held by great numbers of the philosophers who have lived in the brightening ages of Europe: the opinion that, at the basis of the natural order, there is something which we can know to be *unreasonable*, to evade the processes of human thought. The opinion is set forth first by Kant, so far. as I know, in the form of his famous doctrine of the antinomies or contradictions, a later form[1] of which I will endeavor to explain to you. It is said, then, that space must either be infinite or have a boundary. Now, you cannot conceive infinite space; and you cannot conceive that there should be any end to it. Here, then, are two things, one of which must be true, while each of them is inconceivable; so that our thoughts about space are hedged in, as it were, by a contradiction. Again, it is said that matter must either be infinitely divisible, or must consist of small particles incapable of further division. Now, you cannot conceive a piece of matter, divided into an infinite number of parts, while, on the other hand, you cannot conceive a piece of matter, however small, which absolutely cannot be divided into two pieces; for, however great the forces are which join the parts of it together, you can imagine stronger forces able to tear it in pieces. Here, again, there are two statements, one of which must be true, while each of them is separately inconceivable; so that our thoughts about matter also are hedged in by a contradiction. There are several other cases of the same thing, but I have selected these two as instructive examples. And the conclusion to which philosophers were led by the contemplation of them was, that on every side, when we approach the limits of existence, a contradiction must stare us in the face. The doctrine has been developed and extended by the great successors of Kant; and this unreasonable, or unknowable, which is also called the absolute and the unconditioned, has been set forth in various ways as that which we know to be the true basis of all things. As I said before, I approach this doctrine with all the reverence which should be felt for that which has guided the thoughts of so many of the wisest of mankind. Nevertheless, I shall endeavor to show that, in these cases of supposed contradiction, there is always something which we do not know now, but of which we cannot be sure that we shall be ignorant next year. The doctrine is an attempt to found a positive statement upon this ignorance, which can hardly be regarded as justifiable. Spinoza said, "A free man thinks of nothing so little as of death;" it seems to me we may parallel this maxim in the case of thought, and say, "A wise man only remembers his ignorance in order to destroy it." A boundary is that

[1] That of Mr. Herbert Spencer, "First Principles." I believe Kant himself would have admitted that the antinomies do not exist for the empiricist.

which divides two adjacent portions of space. The question, then, "Has space (in general) a boundary?" involves a contradiction in terms, and is, therefore, unmeaning. But the question, "Does space contain a finite number of cubic miles, or an infinite number?" is a perfectly intelligible and reasonable question which remains to be answered by experiment.[1] The surface of the sea would still contain a finite number of square miles, if there were no land to bound it. Whether or no the space in which we live is of this nature remains to be seen. If its extent is finite, we may quite possibly be able to assign that extent next year; if, on the other hand, it has no end, it is true that the knowledge of that fact would be quite different from any knowledge we at present possess, but we have no right to say that such knowledge is impossible. Either the question will be settled once for all, or the extent of space will be shown to be greater than a quantity which will increase from year to year with the improvement of our sources of knowledge. Either alternative is perfectly conceivable, and there is no contradiction. Observe especially that the supposed contradiction arises from the assumption of theoretical exactness in the laws of geometry. Now, the other case that I mentioned has a very similar origin. The idea of a piece of matter the parts of which are held together by forces, and are capable of being torn asunder by greater forces, is entirely derived from the large pieces of matter which we have to deal with. We do not know whether this idea applies in any sense to the *molecules* of gases even; still less can we apply it to the *atoms* of which they are composed. The word "force" is used of two phenomena: the pressure, which when two bodies are in contact connects the motion of each with the position of the other; and attraction or repulsion; that is to say, a change of velocity in one body depending on the position of some other body which is not in contact with it. We do not know that there is any thing corresponding to either of these phenomena in the case of a molecule. A meaning can, however, be given to the question of the divisibility of matter in this way. We may ask if there is any piece of matter so small that its properties as matter depend upon its remaining all in one piece. This question is reasonable; but we cannot answer it at present, though we are not at all sure that we shall be equally ignorant next year. If there is no such piece of matter, no such limit to the division which shall leave it matter, the knowledge of that fact would be different from any of our present knowledge; but we have no right to say that it is impossible. If, on the other hand, there *is* a limit, it is quite possible that we may have measured it by the time the Association meets at Bradford. Again, when we are told that the infinite extent of space, for example, is something that we cannot conceive at present, we may reply that this is only natural, since our experience has never yet supplied us with the

[1] The very important distinction between *unboundedness* and *infinite extent* is made by Riemann, *loc. cit.*

means of conceiving such things. But, then, we cannot be sure that the facts will not make us learn to conceive them; in which case they will cease to be inconceivable. In fact, the putting of limits to human conception must always involve the assumption that our previous experience is universally valid in a theoretical sense; an assumption which we have already seen reason to reject. Now, you will see that our consideration of this opinion has led us to the true sense of the assertion that the order of Nature is reasonable. If you will allow me to define a reasonable question as one which is asked in terms of ideas justified by previous experience, without itself contradicting that experience, then we may say, as the result of our investigation, that to every reasonable question there is an intelligible answer, which either we or posterity may know.

We have, then, come somehow to the following conclusions: By cientific thought we mean the application of past experience to new circumstances, by means of an observed order of events. By saying that this order of events is exact, we mean that it is exact enough to correct experiments by, but we do not mean that it is theoretically or absolutely exact, because we do not know. The process of inference we found to be in itself an assumption of uniformity, and that, as the known exactness of the uniformity became greater, the stringency of the inference increased. By saying that the order of events is reasonable, we do not mean that every thing has a purpose, or that every thing can be explained, or that every thing has a cause; for neither of these is true. But we mean that to every reasonable question there is an intelligible answer, which either we or posterity may know *by the exercise of scientific thought.*

For I especially wish you not to go away with the idea that the exercise of scientific thought is properly confined to the subjects from which my illustrations have been chiefly drawn to-night. When the Roman jurists applied their experience of Roman citizens to dealings between citizens and aliens, showing by the difference of their actions that they regarded the cicumstances as essentially different, they laid the foundations of that great structure which has guided the social progress of Europe. That procedure was an instance of strictly scientific thought. When a poet finds that he has to move a strange new world which his predecessors have not moved; when, nevertheless, he catches fire from their flashes, arms from their armory, sustentation from their footprints, the procedure by which he applies old experience to new circumstances is nothing greater or less than scientific thought. When the moralist, studying the conditions of society and the ideas of right and wrong which have come down to us from a time when war was the normal condition of man and success in war the only chance of survival, evolves from them the conditions and ideas which must accompany a time of peace, when the comradeship of equals is the condition of national success—the process by which he

does this is scientific thought and nothing else. Remember, then, that it is the guide of action; that the truth which it arrives at is not that which we can ideally contemplate without error, but that which we may act upon without fear; and you cannot fail to see that scientific thought is not an accompaniment or condition of human progress, but human progress itself. And for this reason the question what its characters are, of which I have so inadequately endeavored to give you some glimpse, is the question of all questions for the human race. —*Advance-sheets from Macmillan.*

## INTRODUCTION TO "THE GREAT PROBLEM."[1]

By HOWARD CROSBY, D. D., LL. D.,
CHANCELLOR OF THE UNIVERSITY OF NEW YORK.

THE royal Psalmist said, "The heavens declare the glory of God, and the firmament showeth his handy work." The modern Huxleys respond: "The heavens declare nothing at all, and the firmament is ultimately but eternal protoplasm." In this happy and hopeful response the materialists are as much traitors to science as enemies to religion. They *ignore all the facts of mind.* This whole department of cognitions is neglected in arranging their premises. The very first canon of science is thus violated, which demands that *all* facts be collated as data. Then, a second fallacy of which they are guilty is, *leaving scientific proof and leaping, by the imagination, to the conclusion that life is merely matter.* They find an ultimate matter (only ultimate, however, owing to the limited power of the microscope), and straightway say, "This is *life*," although it is known to exist without life, and has not a single characteristic of life in it. By such unscientific methods these scientific men, whose names are now so famous, have imposed upon the unlearned and credulous, and made men lose their faith in the eternal truths of God. Darwinism is another form of the same infidelity, working its evil by the same unscientific methods. Darwin leaps to his conclusions against every axiom of science, and Darwinism is, instead of science, mere theory. Science and Religion are at one. They both come from God and lead to God. "The heavens declare the glory of God," and "the statutes of the Lord are right, rejoicing the heart," are accordant strings of the same harp.

We need sensible and learned men to come forward and show the

[1] "The Great Problem: The Higher Ministry of Nature viewed in the Light of Modern Science; and as an Aid to Advanced Christian Philosophy." By John R. Leifchild, A. M., Author of "Our Coal-Fields and our Coal-Pits," "Cornwall; its Mines and Miners," etc., etc., with an Introduction by Howard Crosby, D. D., LL. D., Chancellor of the University of New York. 543 pages. G. P. Putnam & Sons.

world what fools these pseudo-scientists are, and thus break the spell, which is as groundless as the Cock-lane Ghost, but which holds so many all-agape at their fantastic tricks.

Mr. Leifchild's book is popular, and yet sound and thoughtful. Its style is terse and clear. He represents the materialists and pantheists (the extremes are one) with fairness, and exposes the core of their absurdities, showing the higher ministry of Nature in declaring the glory of God, vindicating the equal authority of our intuitions and our senses, and the separateness, yet intimate connection, of mind and matter. It is a book that should find its way to every parlor, where the materialistic poison has been scattered, to straighten and strengthen the weak knees, and give color to the pallid cheek, letting the light upon the frightful spectre, and showing it to be but a man of straw. It is high time that this buffoonery in the name of science were played out. Scientific and religious men must join to put out the intruder, with a brand upon his back. To hold serious talk with him is only to set him up in his assumption. Mr. Leifchild's book exposes him to the world, pulls off the lion's skin, and turns the public fear into laughter. Let the voice of Truth be heard through a thousand such books, and the cant of materialism shrink into silence.

## FOUL AIR AND DISEASE OF THE HEART.

By CORNELIUS BLACK, M. D. Lond., M. R. C. P.

IF the question were asked, "Which side of the heart is the more frequently affected by disease?" the answer, in perhaps nine cases out of ten, would be, the left. This answer would not, however, embrace the whole truth. It would be true of the aggregate of cases of cardiac disease without reference to age; but it would be untrue if the occurrence of cardiac disease were referred to the later periods of life. If a man lives to the age of forty years without having suffered from cardiac disease, and, if after that period the heart becomes affected, the mischief will, as a rule, be found to exist on the *right* side. If, on the contrary, cardiac disease should occur before that age, the disease will, almost invariably, be found to exist on the *left* side. Hence, it follows that the right side of the heart is the seat of cardiac disease occurring after middle age—the left side of the heart the seat of cardiac disease occurring before middle age.

As in time, so it is with respect to the nature of the diseases which affect the right and left sides of the heart respectively. Those of the right side are the result of tissue-degeneration, or of mere mechanical influences; those of the left side are almost invariably the product of

inflammation. The former are diseases which tend to widen the valvular apertures, and to dilate the right side of the heart; the latter are diseases which tend to contract the valvular apertures, and to increase the size and bulk of the left side of the heart.

Disease of the right side of the heart is essentially passive and secondary in its character; disease of the left side of the heart is essentially active and primary in its character. I speak now of disease when it occurs, not when it has existed for some time. Active inflammation of the left chambers of the heart arises; it progresses to a certain extent; treatment subdues it; the patient recovers; but a certain amount of damage is left behind. Years pass on; the patient during this time appears none the worse for his previous illness; but at length pulmonary symptoms suddenly manifest themselves, and then it is that the physician discovers that the left side of the heart is permanently damaged, and that the present condition of the lungs is traceable to this cause.

In this instance the mischief in the heart inducing this condition of the lungs is not, strictly speaking, active. The first step of the cardiac disease was active; but the second step was chronic. Bit by bit—increment by increment—after the patient's apparent recovery from the primary attack, is the valvular lesion left by such attack added to, not perhaps constantly, but intermittingly, until at length the aggregate increments of addition so hamper, oppress, obstruct, and distort the mitral, or the mitral and aortic valves, that secondary consequences begin to follow.

Why are the affections of the two sides of the heart essentially different in their nature? Why do those of the left side of the heart point to an inflammatory origin; those of the right side of the heart, with but few exceptions, to a non-inflammatory origin? There must be some cause for this difference. What is it? The reason is found in the difference which exists between the constitution of the blood which reaches the left side of the heart from the lungs, and that which reaches the right side of the heart from the general system. The blood reaching the left side of the heart from the lungs has been replenished with all the elements necessary for the growth of the tissues; it has been purified, renovated, and vivified by its oxygenation in the lungs, and it is thus rendered in the highest degree stimulating to the left heart. The blood reaching the right side of the heart from the general system has been deprived, by the requirements of growth, of the chief portion of its nutrient materials; it has been fouled by the *débris* of tissue-waste; it has been further poisoned by its impregnation with carbonic-acid gas: it is therefore a depressant, rather than a healthy excitant, to the right heart. True, it brings with it to the chambers of the right heart the products of the digestion of food; but what are they, either as nutrients or excitants, when they reach that point? They are no more than inert, unusable, passive elements. Not

until they have passed to the lungs, and have there received the vivifying influence of oxygen, can they enter into the real composition of the blood, and thus become active, exciting, disposable constituents of it.

"Like begets like" in very many instances. This axiom is true in relation to diseases of the heart. The rich, stimulating blood of the left ventricle urges, feeds, and actively supports any disease which may arise at that point; while the poor, impoverished, fouled, tainted, and attenuated blood which flows through the cavities of the right heart favors disease of a correspondingly low and degenerate character.

So long as the body is rapidly built up and as rapidly pulled down, disease of the left heart maintains an active character; but when the balance between nutrition and waste is destroyed—when nutrition becomes less active, while waste remains the same, or is more active than before—disease of the left heart loses more and more of its active character, and approximates more and more in its nature to disease of the right heart. In many this change begins at the age of forty; in others, not until five or ten years after that period. Thenceforward the tendency to inflammatory disease of the left heart declines—the tendency to degeneration increases. With the gradual declination of the one tendency and the gradual increase of the other, a period is at length reached when active inflammatory disease ceases, as a rule, to affect the left heart. At this juncture the left and right sides of the heart, hitherto dissimilar in their tendencies, are in this respect almost as one. The active tendency of early life has given place to the passive tendency of advancing years—inflammation to degeneration.

Acute rheumatism—a fruitful cause of cardiac disease in the earlier periods of life—is seldom seen beyond the age of fifty. I have, however, attended a case of acute articular rheumatism at the age of seventy-five; but such an instance was an exception to the rule. After fifty, acute rheumatism gives place to a form of rheumatism which slowly produces rigidity of the coats of the blood-vessels, hardens and contracts the tendons, thickens and renders stiff and rigid the ligaments of the joints, hardens and lessens the articular cartilages.

Thus, then, according to a law of Nature, the *ultima linea* of life ends in—degeneration.

Apart from the influence of this law, can any accidental, casual, or avoidable circumstance favor this immutable tendency to degeneration, speaking more particularly in reference to the heart? Yes; many circumstances are daily, hourly, momentarily doing this. Thousands annually perish from heart-disease, whose lives might and would have been prolonged had but proper attention been given to the simple laws of Nature. These laws demand attention to the three great vital functions—the action of the brain and nervous system, respiration, and circulation.

None of these functions must be overworked, as none of them must fall short of their proper duty. Healthy, regular, daily action is their law of life. If the brain and nervous system are overworked, vitality is lowered, the resisting power of the body is diminished, disease is easily produced. If the brain and nervous system are underworked, the generation of nervous power is low and deficient, the vitality of the tissues becomes low in proportion, and disease is easily excited. Overwork exhausts, ruins, kills the body, just as the continued generation of the galvanic current exhausts the acid and wears out the zinc plate. The weakest point of the body has to bear the result of this violation of Nature's laws. If the heart is that point, disease falls upon it, and death before the legitimate term of man's existence is the consequence.

To keep the body in perfect health it must be duly oxygenated. There must be free and ample interchange between the blood in the lungs and the air entering the pulmonary cells. The life-stream must be purified by its elimination of carbonic acid; it must be vivified by the absorption of oxygen. The fulfilment of these conditions demands a full, free, and constant admission of pure air into the lungs. This full, free, and constant admission of pure air cannot be obtained in badly-ventilated houses, crowded buildings, schools as at present constructed, theatres, manufactories, pits, underground railways, and the like.

When the body has reached that age at which natural decay or degeneration has begun, the absence of pure air hastens and increases the degenerative tendency. Where the heart is more prone than other organs to disease, the want of pure air falls with powerful effect upon the tissues of the right heart. Their nutrition is defective by reason of the impurity of the blood with which they are fed, their vital force is lowered, their muscular fibre loses its tonicity, degeneration and debility take the place of active nutrition and power. If in this condition any stress is thrown upon the heart by hurried walking, by lifting, climbing, violent declamation, passional expression, singing, laughing, or by any unusual exercise of the voice, the tricuspid valve gives way, it henceforth fails to close its aperture, and the results of a back-flooding of blood upon the venous system of the body begin to follow. If none of these exciting causes occur, the continued breathing of impure air is followed by constantly-progressing degeneration of the tissues of the valves and muscular structure of the right heart; they become soft and feeble, their atoms shrink; the segments of the tricuspid are at length unable to meet in their attempt to close their aperture; a small chink or slit is left between them; through this the blood finds its way into the auricle above at every contraction of the heart; and soon regurgitation is followed by the secondary consequences produced in the general system—congestion of the liver, stomach, spleen, kidneys, bowels—by hæmorrhoids, general dropsy, and occasionally by cerebral mischief.

I hold that the breathing of impure air is a fruitful source of disease of the right heart occurring after middle age. How many people ignorantly favor its occurrence by confining themselves to closely-shut, non-ventilated, hot, stifling rooms, in which the carbonic acid has accumulated to 2 or 3 per cent. of the air they respire! How many are thus destroyed by being compelled, through the exigencies of life, to pass the greater part of their time in pits and manufactories where ventilation is defective, or in which the air respired is poisoned by noxious fumes and offensive emanations from the materials undergoing the process of manufacture! How many are falling victims to the poisonous influence upon the heart of the atmosphere of an underground railway! What do these facts suggest? How are these evil results to be prevented? The simple answer is—Let the rooms in which you live be effectually ventilated by an incoming current of air filtered from all adventitious impurities, and so divided that no draught shall be felt; and by an outgoing current which shall remove from the apartments the carbonic acid, carbonic oxide, sulphurous-acid gas, sulphuretted hydrogen, and other noxious compounds, as rapidly as they are generated. Apply the same principle to public buildings, theatres, schools, manufactories, pits, and to all places in which people are accustomed to congregate.

As to underground railways, the best plan is to avoid them. True, the time passed in their polluted atmosphere is usually very short; but it is, nevertheless, sufficiently long to paralyze occasionally the heart's action, and always, by its pollution of the blood and by its direct effect upon the nervous system, to favor degeneration of the structures of the heart.

It often occurs to a medical man to visit a patient for the first time, and to find him suffering from a dilated right heart. He may for some short time have been sensible of a change in his breathing on walking rather quickly, or in mounting the stairs, or he may never have felt, or at least recognized, any such sensations. His attention was first arrested by observing that his feet and ankles were swollen, especially at night on going to bed. This sign it is which gives him the first alarm, and which causes him to seek the aid of his physician. An examination of his case detects a dilated right heart, with incompetency of the tricuspid valve. How has this condition of the heart been brought about? There is no history of previous cardiac disease; there has been no illness ushering in the present condition of things; there has never been, nor is there now, any affection of the lungs, and yet the right heart has suffered a lesion fatal to life! The answer is, that every such case has passed the age of forty, that the tissues of the right heart have entered upon the period of degeneration, and that this degeneration has, with very few exceptions, been hastened by the breathing of an impure air, either during the pursuit of the ordinary occupations of life, or in the patient's own dwelling.

When the degeneration of the right heart has progressed to a certain extent, incompetency of the tricuspid valve follows either with or without the aid of an exciting cause. Hence it is easy to understand why dilatation of the right heart and tricuspid incompetency are often found to exist apart from any previous history of cardiac disease.

The third great vital function which influences the degenerative tendency of the heart is that of the circulation of the blood. To preserve the health of the tissues, the blood must not only be pure and rich in the materials of growth, but it must flow with a certain speed through all the blood-vessels. If the speed with which the blood moves is on the side of either *plus* or *minus* of the standard of health, disease will shortly arise. If it is on the side of *plus*, active disease of the heart, where that organ is the one to suffer, will follow. If on the side of *minus*, tissue degeneration will ensue. Active disease will be the consequence before middle age; degeneration after that period.

These facts teach that all violent and long-continued efforts of the body should be avoided. They hurry the heart's action to an inordinate degree, they cause it to throw the blood with great force into the extreme vessels, and, as there is almost always one organ of the body weaker than the others, the vessels of this organ become distended, and, remaining distended, the organ itself becomes diseased. Running, rowing, lifting, jumping, wrestling, severe horse-exercise, cricket, football, are fruitful causes of heart-disease. Those which require the breath to be suspended during their accomplishment are more fruitful causes in this respect than those which require no such suspension of the breathing. Rowing, lifting heavy weights, wrestling, and jumping, do this; and, of these, rowing is the most powerful for evil. At every effort made with the hands and feet, the muscles are strained to their utmost; the chest is violently fixed; no air is admitted into the lungs; blood is thrown by the goaded heart with great force into the pulmonary vessels; they become distended; they at length cannot find space for more blood; the onward current is now driven back upon the right heart; its cavities and the blood-vessels of its walls become in like manner distended; the foundation of disease is laid. Hypertrophy, hæmoptysis, inflammatory affections of the heart and lungs, are the consequences in the young; valvular incompetency, rupture of the valves or of the muscular fibres of the heart, pulmonary apoplexy, and cerebral hæmorrhage, are too frequently the immediate consequences in those of more mature years.

If the flow of blood is *minus* the standard of health, the heart's walls are imperfectly nourished, by reason of a deficient supply of food within a given time; the blood itself, receiving less aëration, is, in consequence, more impure; degeneration of the heart's walls is thus induced, if it does not already exist—hastened, if it is present.

I propose now to consider the influence of an increasng quantity of

carbonic acid in the air respired upon the contractility of the muscular fibres of the heart.

I take for my example the newly-hatched trout. During the winters of 1869–'70 and 1870–'71, I hatched some thousands of this fish, many of which I daily submitted to microscopical examination. The result of my investigations, in reference to the action of the heart and to the influence upon it of a decreasing quantity of oxygen and an increasing quantity of carbonic acid in the water in which the fish was confined, shows—

That, on placing the fish in a glass trough containing a quantity of water, the heart is seen, under the microscope, to be affected in the following manner:

In the first few moments of examination the venous blood, collected by the veins from the head, back, and yelk-bag (the first two of which unite to form a bulbous vessel into which the third opens), is seen to be projected with considerable force and rapidity into the upper (auricle) of the two cavities of which the heart is composed, and thence as instantaneously into the lower (ventricle) cavity, which contracts with equal rapidity, and forces the blood into the branchial artery, which conveys it to the gills. The projection of the blood into the auricle, its passage into the ventricle, and its expulsion therefrom, are but the work of an instant. As the blood enters the auricle, both it and the ventricle seem to anticipate the charge of blood; but especially is this the case with the ventricle. Before the blood well touches the valve which guards the entrance from auricle to ventricle, the latter is observed to shorten its longitudinal diameter, to visibly meet, as it were, the coming charge of blood from the auricle, and to force it instantly into the branchial artery. There is no delay whatever of the blood in the auricle or ventricle. It is shot in a straight line from the vena cava through the auricle and the auriculo-ventricular valve, caught by the contracting ventricle, and deflected and forced, without a moment's delay, into the branchial artery.

From these observations it was evident that the contraction of the heart was not excited by the distention of its cavities, but that it was induced by the mere impingement of the blood upon its lining membrane. In contracting, the ventricle was seen to roll about one-third upon its axis, by which a portion of that part of it which was previously out of sight was brought into view. As soon as it had delivered its blood into the branchial artery, it relaxed, and increased again its longitudinal diameter, recoiling from systole with an energy and a rapidity equal to those of its contraction.

In three or four minutes the heart is observed to contract both less quickly and less energetically. A very short time after this the blood can be seen gently pouring into the auricle, and thence into the ventricle, which latter now allows itself to be about one-fourth filled before it contracts. It now expels its blood, and again dilates; but its

dilatation, like its contraction, is not so instantaneous as it was when first observed under the miscroscope. In a short time longer the sensibility of the heart is greatly diminished, for the blood is seen to be accumulating in both the auricle and ventricle, but especially in the former, from both of which cavities it is now only partly expelled by the contraction of the heart.

At length, just before death, the blood is seen to flow from the auricle into the ventricle, thence into the branchial artery and along it, the heart being passive during this time, and only now and then at long intervals manifesting a very slight and partial contraction. During the whole of this time the blood is coagulating more and more in the auricle and ventricle, but especially in the former; and, when at length the heart has ceased to beat, the auricle and the vena cava opening into it are fully distended, while the ventricle is only partly distended with black-red blood. In the last moments of life, after the heart has ceased to beat, the branchial artery is seen to be pushing forward its slender current of blood, and to become at length quite empty and transparent.

Here, then, as the oxygen dissolved in the water in which the fish is confined becomes exhausted, and as the carbonic acid increases, the sensibility and contractility of the heart are diminished, and at length entirely destroyed. The negation of oxygen, and the increase of carbonic acid, have culminated in the death of the fish.

*Precisely the same effect is produced upon the human heart by an accumulation of carbonic acid in the air respired.*

In the ordinary condition of the atmosphere, in which carbonic acid does not exceed one part in a thousand parts of that medium, its effects upon the heart are inappreciable. When, however, the carbonic acid has accumulated to the extent of 1 per cent. of the air respired, it begins to produce a slight feeling of faintness, and some degree of uneasiness across the brow. At 2 per cent. the heart's action is quickened, the sense of faintness is greater, there is slight giddiness, with heaviness and constriction of the head, together with nausea. At 3 per cent. all these symptoms are increased. There are vertigo, fluttering of the heart, nausea and sickness, followed by an overwhelming sense of muscular prostration. At this moment the contractions of the heart become very feeble, the skin relaxes, and is bedewed with a cool, clammy perspiration. These symptoms deepen with the increasing quantity of carbonic acid in the air respired until the utmost limit of toleration is reached, beyond which life can no longer be maintained. At this stage lethargy supervenes; and, at the moment of its occurrence, the heart begins to beat less frequently and much less powerfully than before. This condition is the parallel of that observed in the young trout, when the blood begins to accumulate and to coagulate in the auricle and ventricle, and when the heart's sensibility and contractility are reduced in the greatest degree.

From these effects it is certain that confinement to an atmosphere impregnated with carbonic acid, even to the extent of one per cent. only, quickly deranges the function of the heart, and ultimately deteriorates the tissues themselves of that organ.

The greater the percentage of carbonic acid in the air respired, the more quickly and the more profoundly are these effects produced. The constant breathing of air containing one per cent. only of carbonic acid proves fatal to life; but, if it is respired for a short time only, functional disturbance alone is then and there produced. *It is, however, certain that in this functional disturbance lie the germs of organic mischief, and that frequent repetition of the cause will undoubtedly end in organic disease. Hence the impure atmosphere of the bedrooms of the poor, and, indeed, of many of the middle class, proves a sharp spur to the degenerative tendency manifested by the heart, and especially by the right side of the heart, after the age of forty.* Such bedrooms are generally small in their superficial area, low-pitched, and often lighted by a diminutive window, which at night is kept constantly closed; and having a door which opens to the interior of the house, but which is also closed during the occupation of the rooms. Nay, to prevent the slightest admission of fresh air, the crevices of both window and door are most carefully stopped; and, to render the matter still worse, a fire is not unfrequently kept burning during the winter nights.

What must be the effect produced upon the air of such rooms under the conditions named? I take, for example, an average-sized bedroom in the cottages of the poor—say, a room twelve feet long, ten feet wide, and eight feet high. This gives a cubical space of 960 feet, which is not more than half the cubical space allowed each patient in our best-arranged hospitals. In this room, with its diminutive window and door constantly closed, three, four, and frequently a greater number of persons pass the night of eight or ten hours' duration. No provision has been made for the admission of fresh air—none for the escape of the carbonic acid exhaled during respiration. What little provision did exist in the crevices formed by the badly-fitting door and window has been carefully abrogated by sand-bags, rolls of rags, and stuffing of every description. Thus the air of the room becomes poisoned with carbonic acid, and in this condition it is breathed and rebreathed, to the manifest injury of the heart.

A simple calculation will enable us, if not to determine with exactitude, at least to approximate to the amount of carbonic acid exhaled by each sleeper, and consequently to the degree of vitiation which the air of the apartment undergoes. I fix the number of respirations at its minimum—14 per minute; the quantity of air exhaled at each expiration at 20 cubic inches; the quantity of carbonic acid contained in the expired air at 4 per cent.; and the duration of the night at 8 hours. Hence, $14 \times 20 \times 8 \times 60 = 134{,}400$ cubic inches, or 77.77

cubic feet, of air expired by each sleeper during the night of eight hours. This expired air contains 4 per cent. of carbonic acid. ∴100:77.77 :: 4=3.11 cubic feet of carbonic acid exhaled by each sleeper during the night. Suppose the number of sleepers occupying the bedroom to be four, this will give $3.11 \times 4 = 12.44$ cubic feet as the quantity of carbonic acid which is exhaled by the four sleepers during the eight hours of night. The room itself contains 960 cubic feet of air, and through this 12.44 cubic feet of carbonic acid would have been diffused by the termination of the night. It therefore follows that, if no fresh air entered the room, and if in consequence the carbonic acid had no means of escape, the air of the apartment would, at the end of the eight hours of night, contain 1.29 per cent. of this gas: a quantity sufficient to produce serious results.

This statement, however, does not represent all the facts of the case. It must be remembered that the oxygen contained in the air of the room would be constantly undergoing reduction by respiration during the night. If the quantity thus consumed were determined from the quantity of carbonic acid exhaled, allowing for the fact that 15 per cent. more oxygen is taken into the blood than is contained in the carbonic acid of the air expired, it will be found that from one-third to one-half of the oxygen originally contained in the air of the room would have been consumed by the end of the night. This reduction in the quantity of oxygen, and the great increase of carbonic acid, would affect the body in two ways: firstly, by a deficiency of oxygen; and, secondly, by an excess of carbonic acid, in the air respired. Hence the reduction of the one and the increase of the other would render the air far more injurious than if only one of these changes in its constitution had taken place.

The actual result is not, however, in strict accordance with this calculation, because fresh air, although in limited quantity, does find its way into the room, and carbonic acid does, to a limited extent, find its way out. These, therefore, would modify the constitution of the air of the room at the close of night; but they would still leave it with an excess of carbonic acid injurious to life.

It is found that when air moderately impregnated with carbonic acid is inspired it greatly impedes the exhalation of more from the lungs; and that the greatest quantity of carbonic acid which exists in prebreathed air never exceeds 10 per cent. It is much to be feared that to this degree of vitiation the air of the bedrooms of the poor and of others not unfrequently rises by the too prevalent system of excluding fresh air, and by the frequent absence of provision for the escape of that which has already passed through the lungs.

Can it then be a matter of surprise that death from diseased heart should so often occur during the night?

*In thousands of instances of cardiac disease life is thus sacrificed, where, had but proper ventilation of the bedrooms been observed, the*

*subjects of such disease might, despite the cardiac mischief, have continued to live for an indefinite time.*

It has frequently been my duty, during a practice of nearly thirty years in the midst of a large community prone by the habits and particular avocations of the people to heart-disease, to investigate cases of "found dead" in bed, and I have often been compelled to refer the immediate cause of death to the effect of carbonic acid liberated by respiration and confined to the apartment, in destroying the sensibility and contractility of the heart, rather than to the direct influence of the diseased heart itself.

I remember that on one occasion I was summoned to a case which had occurred in a bedroom fifteen feet long, twelve feet wide, and eight feet high. In this room, with the door and window closed, no fewer than twenty persons slept night after night! Can any one doubt that the air of such a room would be charged to excess with carbonic acid exhaled by respiration? Those who perished in this manner were beyond the age of forty; and, in every instance examined, the right side of the heart was either primarily affected by tissue-degeneration, or by disease consecutive to mischief in the left side of the heart and lungs.

Often indeed in the dwellings of the middle and higher classes of society the provisions for ventilating both their bedrooms and their day-rooms are miserably inadequate to preserve health. The consequence is, that cardiac disease is promoted to an inconceivable extent. *There is no other disease in which the demand for cold, fresh air is so urgently pressed by the patient as in cardiac disease. There is none in which a constant supply of pure air is more needed—none in which it is more grateful to the patient, or in which it has a more immediately beneficial effect.* At all times and seasons—in the depth of winter—by day and by night—a patient suffering from a paroxysm of cardiac asthma will hurry to the open door or window, and there, with his body hanging half out, will remain, with scarcely any vestments upon him, breathing the cold air until the paroxysm has ceased. Ought not this urgent, this powerful supplication of Nature to teach us the importance of ventilation, and of a full supply of fresh air in the treatment of heart-disease?

*I hesitate not to say that free ventilation—the free admission of pure air into the apartment by day and by night—is one of the most important remedial measures which can be adopted in the treatment of this disease.*

Where this means is defective, but where, nevertheless, the vitiation of the air of the bedroom does not exceed 1 per cent. of carbonic acid, a sensible effect is produced upon those who have slept within its influence. They complain, on leaving their bed, of weakness; their limbs tremble; they feel somewhat giddy, and their head feels heavy, or it aches. The least effort disturbs the heart's action, which is some-

what quick and feeble; their countenance is pale; the lips are not unfrequently somewhat blue; and the tongue is covered with a thin, whitish, and somewhat slimy fur. The appetite is in abeyance; there is a feeling of nausea; and the first evacuation is generally dark in color.

What is the pathological condition of such patients at this moment? Simply this: The blood contains an excess of carbonic acid, which, circulating with the blood through every organ, disturbs the natural action of every organ, blunting its sensibility, vitiating its particular function, and interfering with those molecular changes which constitute healthy nutrition.

A person thus affected does not usually die. The body, removed to a pure atmosphere, begins at once to excrete the carbonic acid by the lungs, the liver, the skin, the kidneys, and the bowels, and in the course of a few hours the more visible manifestations of its baneful effects have passed away. It, however, often happens that a sense of weariness and muscular debility is felt for days afterward. Night, too, frequently places such subjects in the same condition as before. The same bedroom is occupied; the same inadequate means of ventilation continue; the same accumulation of carbonic acid takes place; and the same effects upon the bodily organs are repeated. Blood charged with an excess of carbonic acid again pervades every tissue of the heart, diminishing its vitality, lowering its sensibility, and assimilating its nutrition to that of the reptilian heart. But the low character of the nutrition of the reptilian heart does not accord with the comparatively quick circulation, rapid nutrition, vital power, and energy of action required by the human heart. The one cannot be substituted for the other. In man the change results in disease where disease does not exist—aggravates disease where it is already present. —*Lancet.*

## FORESTS AND FRUIT-GROWING.

By J. STAHL PATTERSON, Esq.

FRUIT has become a necessary of life—a great variety of fruit indeed, and a great deal of it; and this will become more and more the case with the increase of intelligence and thrift. The great abundance of most kinds of fruit for the last two or three years may cause us to feel a security, which is not well grounded, with regard to the conditions of climate necessary to the unfailing production of fruit. Only within a few years past have there been seasons when the fruit-crop was very light, and not at all adequate to the demand. One of the causes of this is the capriciousness of the seasons, and this capri

ciousness, I believe, is becoming constantly greater as the country grows older.

An inquiry, then, of much scientific interest, and of great material importance, has reference to what may be the cause of this increasing uncertainty of the fruit crop. In the early settlement of the country, it was easy to grow peaches, even in localities where growing peaches now seldom gladden the eye. In Ohio between the parallels of 40° and 41°, for example, peach-buds were seldom injured by winter or spring frosts, and the crop was abundant almost every year when the country was "new." For the last twenty-five years peaches miss oftener than they hit, and in many parts this has told so fearfully against the enterprise of production that scarcely a peach-tree is now to be seen.

The clearing of the country had made this change. The continued clearing of the country will increase the mischief still more. The growing of peaches and of most other fruits will be driven, as indeed it already has been, to special localities and special soils. It is now for such localities to look out in time and preserve as far as possible the favorable conditions they now have, and if possible to increase them.

More especial reference is here had to that part of our country which lies north of the fortieth parallel, where most of the fruit-localities are to be found in the vicinity of considerable bodies of water.

The water absorbs heat during the summer, which it slowly gives off on the approach of cold weather, warming the atmosphere in its vicinity, and preventing the occurrence of early frosts in the fall along the shore-border from five to ten miles wide. This gives the wood and buds a chance to mature thoroughly, so that they will endure a harder freeze in the winter than wood and buds which were suddenly stopped in the course of maturing by an early frost in the fall. In the spring the waters warm more slowly than the land, and the atmosphere thus chilled along this same shore-belt keeps back vegetation and fruit-buds so as greatly to lessen the danger from late frosts; and what may seem to be a contradiction, but is nevertheless true, spring frosts are usually lighter within than they are outside this shore-belt.

These several advantages from the proximity of a considerable body of water are well understood. There is another, however, that may be of some value. During the heated term of summer there is always a cool breeze from the water which modifies the temperature of the hottest part of the day along this otherwise favored border of shore-land, and may act beneficially in various ways: first, by promoting a more active circulation of air among the leaves and young branches, thereby favoring the healthy action of the organic surfaces—hence, greater immunity from blight and mildew in this region; secondly, by affording protection against the injury to which growing fruit is liable from excessive heat; thirdly, by maintaining a greater uniformity of heat between night and day. The experiments of Köppen have shown

that change of temperature alone is deleterious to vegetable growth; and we may, perhaps, justly infer that uniformity of temperature, when it lies at or near that degree which is most favorable to healthy vegetable activity, is a desirable point in a fruit-growing climate for the even, early, and better maturing of fruit.[1]

The influence of forests on rainfall is still an unsettled question. It is a very general impression that forests, in some way, promote the fall of rain when it would not occur if the same region was bare of trees. A great array of authorities may be quoted in favor of this view. It is believed that Spain, parts of France, Switzerland, and the Tyrol, Northern Africa, Persia and Palestine, Egypt and India, the islands Malta and Mauritius, the Cape Verd Islands, and most of the West Indies, have either been turned into deserts or greatly injured by the destruction of their forests, and the blight and droughts which have followed. It is alleged, too, that the planting of forests has in some instances, as in Scotland, Egypt, and St. Helena, caused a more abundant rainfall. But these alleged results, though supported by great names in science, are disputed. Forests may affect rainfall for any thing positively known, but the evidence that they do so is not such as science can accept.[2] But, however this may be, they have doubtless much to do with the benefit which vegetation receives from the rain that does fall.

In a country quite destitute of timber the surface would dry off much more quickly, in consequence of the free sweep afforded to the winds. The water from rains would also pass over the surface more freely into the brooks, and be thus lost to vegetation. The spongy surface of the forest absorbs a larger proportion of rain than the open fields, and thus retains it in the soil as a source from which the neigh-

[1] Both De Vries and Sachs ascertained that every kind of plant has its special degree of temperature at which it makes most growth in a given time; but, while Köppen recognized this, his investigations have made an addition to our knowledge of the subject, his point being that the plant grows more when kept at a uniform temperature than if it had varied between extremes of which this temperature is the mean, thus showing that variation of temperature acts as a check on growth.

According to Karsten, great and sudden changes injure the health and hardiness of plants; while De Vries comes to a directly opposite conclusion. This, however, does not affect Köppen's result, which has reference to rapidity of growth. Moreover, even if great daily variation of temperature should not affect the health of plants, it might, nevertheless, be not wholly harmless to the tenderer fruits.

The preceding paragraphs have been suggested by the kinship between forests and lakes in their influence on climate and fruit-growing.

[2] Since writing the above, we have happened to fall upon several statements in favor of the influence of forests on rainfall, some of them from respectable scientific sources, Proctor, Bryant, Colver, etc. I learn, however, that Prof. Henry, of the Smithsonian Institution, has recently reported that observations for the last twenty years in this country show no appreciable influence of forests on the amount of rainfall. This should carry much more weight with it than the mere fashion of opinion about forests causing rain.

boring streams receive a continual supply, while its evaporation from the surface and its transpiration through the leaves of the trees afford moisture to the atmosphere.

The moisture thus imparted to the atmosphere mitigates the severity of a drought in various ways: First, by lessening evaporation from the surface, as this is accelerated by a dry atmosphere, and retarded by a moist one; secondly, by affording to the soil a greater proportion of moisture for condensation, when the surface cools at night. Thirdly, by affording moisture for direct absorption by the leaves. This is a disputed point among men of science; but the late researches of Cailletet promise a reconciliation of the conflicting views, as usual, by showing that both were wrong and both right. He found that, when a plant was abundantly supplied with moisture in the soil, the leaves never absorb; but that they do absorb whenever the soil is deficient in moisture, and the leaves begin to droop.

Hence, there might be evidence of drought in a country without forests, while there were no such evidences in a country sufficiently guarded by forests, though the amount of rain had been the same in both.

These considerations are not altogether without value in regard to fruit-growing. It is true that grapes do best in rather a dry climate; but most kinds of fruit require considerable moisture, especially at the time of transplanting, and also when the fruit is maturing. In affording some mitigation of the extreme effects of dry weather, forests may be regarded as having a beneficial influence on the growing of most fruits.

Of far greater concern to the fruit-interests of any locality is the influence of woodland on temperature. On this subject there is quite a general unanimity of opinion. Certain forms of the evidence are so familiar that the conviction produced is general. Every one, who has travelled through woodlands and open fields during cold weather, has readily perceived how much warmer was the atmosphere of the wood than that of the field. It is said that engineers on our railroads find that it requires less fuel to keep up steam in passing through a long stretch of woodland (Marsh). But the warming influence of the forest has been subjected to more rigid tests than these. Boussingault proved that, within several parallels of the equator on either side, the temperature of cleared land is about two degrees higher than that which is covered with forest. But we are more directly concerned with results in our temperate climate.

The researches of Becquerel, Krutsch, and Berger, had appeared to prove, first, that a wooded region would have a cooler summer and a warmer winter than a region almost destitute of woods; and, secondly, that during the daytime the temperature of the atmosphere in the forest would always be lower, and during the night always higher, than in the open field; the difference between the diurnal maximum and

minimum of the forest being less than that of the field; in other words, the diurnal temperature is more uniform.

But this is a matter involving such complicated and varying conditions, that absolute propositions are open to question, however true they may be with proper qualifications. Rivoli has very recently done much to make our knowledge of this subject definite. His observations were carefully made, under circumstances which eliminated, as much as possible, all disturbing conditions; there being no body of water near, the country level, and the wind having a fair sweep in all directions. We will state the results of his investigations as briefly as possible.

*Influence of Forests on Winter Temperature.*—In the winter-time, the simplest relations of the forest to temperature prevail. During this season of the year, when the wind passes into the north and becomes colder, the forest warms it; when it passes into the south and becomes warmer, the forest cools it. During winter the forest plays the *rôle* of a bad conductor, and acts as an equalizer of temperature.

*Influence of Forests on Summer Temperature.*—In summer the case is not so simple, owing to evaporation from the surface, transpiration through the leaves, and radiation from them. At this season of the year the atmosphere in the forest is usually warmer during the nights and colder during the day than in the open field. The night is warmer in consequence of the obstruction which the mass of foliage presents to radiation from the surface beneath it; the day is cooler in consequence of the transpiration of vapor from the leaves, and the obstruction interposed between the surface and the direct rays of the sun. In the summer, as well as in the winter, the forest usually acts as an equalizer of the temperature of the atmosphere.

While, however, this is usually the case, there are exceptions. During nights when it is calm, radiation from the leaves of the trees may cool particles of air, which, descending toward the surface, form just before daybreak a stratum of the atmosphere below, which is colder than if the region had been destitute of trees. It is within the experience of most cultivators of the soil that frosts sometimes strike hardest near a wood.

To the fact that under certain circumstances a forest may cause frost in the fields near by, we may add the qualification that this can only occur in the case of white frosts, and that whenever there is motion of the atmosphere, and the wind a cold one, the influence of the forest is always protective. An orchard sheltered by a wood may escape unhurt, while another in the same neighborhood not so protected may suffer the loss of its entire crop. This is believed to be not a very uncommon occurrence in the case of peaches.

If the fruit-growing interest of the country were to state its account with the forest, we should suppose it to be something like the following:

*The Count against Forests.*—1. Unfavorable to the free circulation of the atmosphere in summer-time; in this respect the influence of the forest is directly the opposite to that of an adjacent body of water. 2. Imparting moisture to the atmosphere, whereby, under certain conditions of the weather, the heat may become too great for the good of growing fruit. 3. Causing an occasional late frost in the spring. 4. Affording a harbor for birds and birds'-nests. This is no small consideration in some localities, where birds have to be slaughtered by the ten thousand to save certain kinds of fruit, as cherries, blackberries, and Delaware grapes. I speak advisedly, being well aware of the sentimentalism against which I offend. Some kinds of birds are, of course, only innocent and useful. I make no charge against them (nor against the forest which protects them). Let them live and sing! But, that birds which prey so remorselessly on fruits destroy insects enough to pay for the fruit they waste and consume, is very improbable, and we let the count stand against the trees and bushes that shelter them.

*The Count in favor of Forests.*—1. Usually equalizing the temperature between night and day during the summer-season—uniformity of temperature being a condition which is favorable to vegetable development. 2. Equalizing the effects of rainfall by storing up the waters to be given off gradually to the streams and the atmosphere, thus favoring the development of most kinds of fruit. 3. Imparting moisture to the atmosphere by transpiration through the leaves, and thus profiting the fields in various ways during a drought. This moisture may also contribute to the warmth of the atmosphere when warmth is beneficial. 4. Intercepting the sweep of the winds, and thereby lessening the mechanical injury to plants and trees, and weakening the coöperation for mischief of wind and cold. As a screen for protection against the wind, trees are not without appreciation, and it is generally understood that, even if they imparted no warmth to a cold wind passing through them, the mechanical resistance they afford prevents it from taking the warmth so readily out of vines, trees, and the soil. 5. Cooling the warm winds of winter and spring, thereby keeping back vegetation out of the way of late spring frosts. 6. Warming the cold winds in winter. The last three on the list being by far the most important; and by their coöperation they might very easily, and often do, make the difference, at a critical time, of a crop or no crop, as this often depends on a degree or two of temperature.

It will be readily perceived that all the better influences of wooded lands are of very much the same character as the influence of a body of water. It is when these two classes of conditions meet in the same locality that general fruit-growing has its best chances of success.

What proportion of woodland should remain in the interest of protection for agricultural and horticultural purposes, might be difficult

to ascertain. Different localities would no doubt require a different proportion. Rentzsch (quoted by Marsh) estimates that for the interior of Germany about 23 per cent., and along the coast 20 per cent., is necessary for the needed protection. The case hardly admits of such precision; more would no doubt be better, and in a dry climate like ours, more than anywhere else.

So rapidly is the destruction of timber going on in this country that many localities originally covered with forest have not so great a proportion as this remaining, and other localities are in a fair way soon to be in the same condition. This is becoming, or at least should become, a real cause of apprehension to those who have the welfare of the farming interest, and especially of the fruit-growing interest, at heart. This continuous destruction of timber must eventually result in injury to the market value of lands in certain neighborhoods, especially lands for fruit-growing purposes.

The remnants of forests in the States have another enemy as inexorable and remorseless as the woodman's axe. Many forest-trees, like the wild Indian, do not seem to flourish in the midst of civilization. They first show signs of decay at the top. This takes place after the underbrush has been cleared away and the surface has lost that perfect mulch of decayed leaves which belongs to native forests. The trees are now liable to suffer from extremes of drought as never before. This change is equal to a change of habitat, and the consequence to some varieties of trees is loss of health and vitality.

According to the experiments of Prof. Pfaff made on an oak-tree, the amount of moisture lost by transpiration during the summer-season was more than eight times the quantity of rainfall on the same area for the same time. Dr. Hahn, who thinks this estimate quite too high, says, nevertheless, that "Herr Pfaff's results show us what an enormous quantity of water is required by isolated trees in a comparatively dry and free (*bewegten*) atmosphere, and how much they need the protection which they afford to each other in their combined capacity as a forest." Whenever the balance and integrity of the original forest is broken, the supply of water during droughts not being equal to the demand of trees now suffering the double disadvantage of needing more moisture and less of it available than before, death begins in the topmost branches, that part of the tree which is most exposed to the conditions of active transpiration and farthest removed from the source of moisture.

What should we do about this blight? Save the timber by using it before it is injured, and plant enough to make up for the loss.

For the application of the facts as now ascertained, let us take the southern shore of Lake Erie, which is a good fruit-region lying midway between the Eastern and Western cities, and affording to both part of their supply of fruit. Fruit does not do so well here now as it did in the early settlement of the country. Cut off the timber which still

remains, and the injury to fruit-growing would be still greater; and so far as this result would have an effect, it would be to depreciate the market value of land. What this region especially needs is a protection of woodland against the cold westerly and southwesterly winds to coöperate with the benign influence of the lake in other regards. The more forest to the south of this belt of shore-land the better. The more frequently blocks and belts of woodland intervene throughout its entire extent for immediate local shelter and a general screen against westerly winds, the better for the farming and fruit-growing interests of this region.

But, so long as it pays an immediate profit to cut down the forest, it will be done. It is not within the province of legislation to stop it. There is no hope from voluntary concert of action. A certain percentage of timbered lands might be exempted from taxation; but this innovation, though talked of, is slow in coming about.[1] To a certain extent tree-destruction should be offset by tree-planting. The planter might not receive his profits so quickly as the destroyer, but nevertheless, wherever timber is likely soon to become scarce, and that is almost everywhere, profits would be sure to accrue from direct sales as well as from the value thus added to the land generally—and, besides the profits in dollars and cents, that accruing from the consciousness of having done a beneficent action.

There are a great many purposes for which timber, and timber only can be used; and for these purposes it should be religiously conserved. I once heard a gentleman say, "I don't worship my timber;" he sacrificed it to gain, in a perfectly legitimate manner it is true. Still the writer must say that he has a sincere respect for the "worship of timber;" it is not a bad kind of religion, so far as it goes.

Immense quantities of timber are slaughtered every year for fuel, and this, too, in a country where there is more coal than anywhere else in the world. There is but one way to stop this branch of the destroying process, and that is by increasing railroad facilities so as to make our coal-fields accessible to every part of the country. Cheap coal will save the timber. When no longer consumed in the millions of household fires in city and country, or in furnaces for the driving power of locomotives and mills, great will be the saving of timber for the necessary purposes for which timber must be used, and for the protection of our cultivated fields and gardens.

The burning of Chicago must make an immediate draft on timbered lands for certain purposes of building for which timber is still largely used. But this great fire, in proving the absolute necessity of building cities of brick, stone, and iron, will operate eventually to the saving of timber and the longer continuance of the protection which our northern

[1] Only Missouri, Nebraska, and Illinois, have legislative enactments to encourage the planting of timber. New York, Massachusetts, and California, do something in the same direction through their agricultural societies.

forests afford against northern winds to the great agricultural districts which lie to the south of them.

And here I cannot but refer to a most short-sighted policy which our Government has been pursuing in giving a factitious value to lumber made from our own timber, by a so-called protective tax on foreign lumber. While this has operated directly against the building interests of our own people, it, at the same time, has led to the more rapid destruction of our own forests; and, in thus giving protection to the capital employed in lumbering, it is removing the protection which our forests afford to the American agriculturist, thus damaging the people at large in a twofold manner. This must be the case just so far as the forests belonging to the United States afford greater protection to our cultivated fields than is afforded by the forests of Canada. We do not realize the benign influence which our forests to the west and east of the great lakes exercise upon the climate and agriculture of the country. Imagine them all removed; the cold winds from the northwest and northeast, having unobstructed sweep, would reach us with greater force, and, passing over a bleak and treeless region, they would come to us absolutely colder. Our Government, by its protective policy, has been doing something to bring about this undesirable result. It is high time that a wiser policy should prevail, and that the Government should protect by taking its hands off.[1] (It is gratifying to record that, since the above was written, the duty on lumber has been greatly reduced.)

There is no need of attributing more to forests than is their due. There are storms against which they afford no protection—avalanches of cold which rush down upon the country, killing fruit-buds, and even vines, shrubs, and trees. But these are exceptional. It is in the case of somewhat milder cold-storms that forests save, when without them there would be ruin. The great fact of the increasing uncertainty of fruit and agricultural crops with the continued clearing of the country, is a fact so patent, and of import so significant, that it alone is sufficient to prove the great value of forests for protection, and to put us on guard against their wanton destruction.

[1] According to an estimate in the Report of the Department of Agriculture for 1870, all the pine-timber in the region between the Mississippi on the west and Lakes Superior and Michigan on the north and east, will, at the present rate of consumption, disappear within the next twelve years, while the hard wood will last only about twelve years longer. Lumbermen do not take all, but what they leave is consumed by the fires which generally follow. About 330,000 acres are denuded annually in this region. This is only a part, perhaps, about half the annual consumption of timber in the northwestern section of our country. To compensate for this loss only about 150,000 acres are annually planted in timber throughout the entire West.

This destruction of timber is general. Even fruit-localities are not spared, as the writer has had abundant opportunity to witness, where the demand for railroad ties at high prices has created almost a *furor* for coining money out of the great oaks, regardless of consequences to climate and culture.

The alarm about the destruction of timber in this country is only too well founded.

# A NEW THEORY OF VOLCANOES.

THERE are few subjects less satisfactorily treated in scientific treatises than that which Humboldt calls the Reaction of the Earth's Interior. We find, not merely in the configuration of the earth's crust, but in actual and very remarkable phenomena, evidence of subterranean forces of great activity, and the problems suggested seem in no sense impracticable, yet no theory of the earth's volcanic energy has yet gained general acceptance. While the astronomer tells us of the constitution of orbs millions of times farther away than our own sun, the geologist has hitherto been unable to give an account of the forces which agitate the crust of the orb on which we live.

A theory has just been put forward respecting volcanic energy, however, by the eminent seismologist Mallet, which promises not merely to take the place of all others, but to gain a degree of acceptance which has not been accorded to any theory previously enunciated. It is, in principle, exceedingly simple, though many of the details (into which we do not propose to enter) involve questions of considerable difficulty.

Let us, in the first place, consider briefly the various explanations which had been already advanced. There was first the chemical theory of volcanic energy, the favorite theory of Sir Humphry Davy. It is possible to produce on a small scale nearly all the phenomena due to subterranean activity, by simply bringing together certain substances, and leaving them to undergo the chemical changes due to their association. As a familiar instance of explosive action thus occasioned, we need only mention the results experienced when any one, unfamiliar with the methods of treating lime, endeavors over-hastily to "slake" or "slack" it with water. Indeed, one of the strong points of the chemical theory consisted in the circumstance that volcanoes only occur where water can reach the subterranean regions—or as Mallet expresses it, that "without water there is no volcano." But the theory is disposed of by the fact, now generally admitted, that the chemical energies of our earth's materials were almost wholly exhausted before the surface was consolidated.

Another inviting theory is that according to which the earth is regarded as a mere shell of solid matter surrounding a molten nucleus. There is every reason to believe that the whole interior of the earth is in a state of intense heat; and if the increase of heat with depth (as shown in our mines) is supposed to continue uniformly, we find that at very moderate depths a degree of heat must prevail sufficient to liquefy any known solids under ordinary conditions. But the conditions under which matter exists a few miles only below the surface of the earth are not ordinary; the pressure enormously exceeds any

which our physicists can obtain experimentally. The ordinary distinction between solids and liquids cannot exist at that enormous pressure; a mass of cold steel could be as plastic as any of the glutinous liquids, while the structural change which a solid undergoes in the process of liquefying could not take place under such pressure even at an enormously high temperature. It is now generally admitted that, if the earth really has a molten nucleus, the solid crust must, nevertheless, be far too thick to be in any way disturbed by changes affecting the liquid matter beneath.

Yet another theory has found advocates. The mathematician Hopkins, whose analysis of the molten-nucleus theory was mainly effective in rendering that theory untenable, suggested that there may be isolated subterranean lakes of fiery matter, and that these may be the true seat of volcanic energy. But such lakes could not maintain their heat for ages, if surrounded (as the theory requires) by cooler solid matter, especially as the theory also requires that water should have access to them. It will be observed also that none of the theories just described affords any direct account of those various features of the earth's surface—mountain-ranges, table-lands, volcanic regions, and so on—which are undoubtedly due to the action of subterranean forces. The theory advanced by Mr. Mallet is open to none of these objections. It seems, indeed, competent to explain all the facts which have hitherto appeared most perplexing.

It is recognized by physicists that our earth is gradually parting with its heat. As it cools it contracts. Now, if this process of contraction took place uniformly, no subterranean action would result. But, if the interior contracts more quickly than the crust, the latter must in some way or other force its way down to the retreating nucleus. Mr. Mallet shows that the hotter internal portion must contract faster than the relatively cool crust; and then he shows that the shrinkage of the crust is competent to occasion all the known phenomena of volcanic action. In the distant ages when the earth was still fashioning, the shrinkage produced the *irregularities of level* which we recognize in the elevation of the land and the depression of the ocean-bed. Then came the period when, as the crust shrank, it formed *corrugations;* in other words, when the foldings and elevations of the somewhat thickened crust gave rise to the mountain-ranges of the earth. Lastly, as the globe gradually lost its extremely high temperature, the continuance of the same process of shrinkage led no longer to the formation of ridges and table-lands, but to local crushing down and dislocation. This process is still going on, and Mr. Mallet not only recognizes here the origin of earthquakes, and of the changes of level now in progress, but the true cause of volcanic heat. The modern theory of heat as a form of motion here comes into play. As the solid crust closes in upon the shrinking nucleus, the work expended in crushing down and dislocating the parts of the crust is

transformed into heat, by which, at the places where the process goes on with greatest energy, "the material of the rock so crushed and of that adjacent to it are heated even to fusion. The access of water to such points determines volcanic eruption."

Now, all this is not mere theorizing. Mr. Mallet does not come before the scientific world with an ingenious speculation, which may or may not be confirmed by observation and experiment. He has measured and weighed the forces of which he speaks. He is able to tell precisely what proportion of the actual energy which must be developed as the earth contracts is necessary for the production of observed volcanic phenomena. It is probable that nine-tenths of those who have read these lines would be disposed to think that the contraction of the earth must be far too slow to produce effects so stupendous as those which we recognize in the volcano and the earthquake. But Mr. Mallet is able to show, by calculations which cannot be disputed, that less than one-fourth of the heat at present annually lost by the earth is sufficient to account for the total annual volcanic action, according to the best data at present in our possession.

This would clearly not be the place to follow out Mr. Mallet's admirable theory into all its details. We must content ourselves with pointing out how excellently it accounts for certain peculiarities of the earth's surface-configuration. Few that have studied carefully-drawn charts of the chief mountain-ranges can have failed to notice that the arrangement of these ranges does not accord with the idea of upheaval through the action of internal forces. But it will be at once recognized that the aspect of the mountain-ranges accords exactly with what would be expected to result from such a process of contraction as Mr. Mallet has indicated. The shrivelled skin of an apple affords no inapt representation of the corrugated surface of our earth, and, according to the new theory, the shrivelling of such a skin is precisely analogous to the processes at work upon the earth when mountain-ranges were being formed. Again, there are few students of geology who have not found a source of perplexity in the foldings and overlappings of strata in mountainous regions. No forces of upheaval seem competent to produce this arrangement. But by the new theory this feature of the earth's surface is at once explained; indeed, no other arrangement could be looked for.

It is worthy of notice that Mr. Mallet's theory of volcanic energy is completely opposed to ordinary ideas respecting earthquakes and volcanoes. We have been accustomed vaguely to regard these phenomena as due to the eruptive outbursting power of the earth's interior; we shall now have to consider them as due to the subsidence and shrinkage of the earth's exterior. Mountains have not been upheaved, but valleys have sunk down. And in another respect the new theory tends to modify views which have been generally entertained in recent times. Our most eminent geologists have taught that the

earth's internal forces may be as active now as in the epochs when the mountain-ranges were formed. But Mr. Mallet's theory tends to show that the volcanic energy of the earth is a declining force. Its chief action had already been exerted when mountains began to be formed; what remains now is but the minutest fraction of the volcanic energy of the mountain-forming era; and each year, as the earth parts with more and more of its internal heat, the sources of her subterranean energy are more and more exhausted. The thought once entertained by astronomers, that the earth might explode like a bomb, her scattered fragments producing a ring of bodies resembling the zone of asteriods, seems further than ever from probability; if ever there was any danger of such a catastrophe, the danger has long since passed away.—*Spectator.*

## GREAT FIRES AND RAIN-STORMS.

BY JOHN TROWBRIDGE,

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THE belief that great fires are followed invariably by rain-storms is wide-spread, and the great fires of the present year in America, it is claimed, afford no exception to the law. The attitude of scientific men in regard to so-called popular fallacies and superstitions is not, in general, a praiseworthy one. A belief needs often only to be wide-spread among the people at large to be denounced. Science is but another word for truth, and even popular traditions deserve to be examined with care. The difficulties, however, in the way of an investigation of the effects of fires in producing rain-storms are manifold. Our knowledge of the science of meteorology is, at the best, very imperfect; and we have no series of observations from which we can draw trustworthy conclusions. A careful search into the narratives of great fires and into the accounts of great naval and land fights gives nothing which a scientific man would accept for a moment. One who is ready and determined to believe, it is true, will find in history many curious and apparent corroborations of the truth of his belief. Thus in Pepys's "Diary" there is a quaint and circumstantial account of the great fire in London. In speaking of the progress of the fire, he says: "So as we were forced to begin to pack up our own goods, and prepare for their removal; and did by moonshine (*it being brave dry and moonshine and warm weather*) carry much of my goods into the garden;" and in another place: "But Lord! what a sad sight it was by *moonlight* to see the whole city almost on fire that you might see it plain at Woolwich, as if you were by it." In still another place, in speaking of the poor sufferers made homeless by the fire: "A great blessing it is to them that it is fair weather for them to keep abroad night and day." He thus

concludes: "*Sunday.*—So to my office, there to write down my journall, and take leave of my brother, whom I send back this afternoon, though raining; *which it hath not done a good while before.*"

After reading this, we turn to the account of the burning of Moscow. But this occurred in September, and the equinoctial gales were blowing fiercely at the time. If we look into the history of land and sea fights, we find many striking and apparent confirmations of the truth of the popular belief. Froude concludes his description of the fight at Flores, 1591, as follows: "Nor did the matter end without a sequel awful as itself." Sea-battles have been often followed by storms, and without a miracle; but with a miracle, as the Spaniards and the English alike believed, or without one, as we moderns would prefer believing. "There ensued on this action a tempest so terrible as was never seen or heard the like before." The human mind is undoubtedly prone to connect great calamities together, and to believe that the one following depended in some mysterious way upon the one preceding.

We turn now to the great fire at Chicago. It was telegraphed to London, England, that "this fire was chiefly checked on the third or fourth day by the heavy and continuous down-pour of rain, which, it is conjectured, was partly due to the great atmospheric disturbances which such an extensive fire would cause, especially when we are told that the season just previous to the outbreak of the fire had been particularly dry." In an article published in the "Journal of the Franklin Institute," July, 1872, by Prof. I. A. Lapham, assistant to the Chief-Signal Officer U. S. A., entitled "The Great Fires of 1871 in the Northwest," we find the following in regard to the burning of Chicago: "During all this time—twenty-four hours of continuous conflagration upon the largest scale—no rain was seen to fall, nor did any rain fall until four o'clock the next morning; and this was not a very considerable 'down-pour,' but only a gentle rain, that extended over a large district of country, differing in no respect from the usual rains. The quantity, as reported by meteorological observers at various points, was only a few hundredths of an inch. It was not until four days afterward that any thing like a heavy rain occurred. It is therefore quite certain that this case cannot be referred to as an example of the production of rain by a great fire. Must we therefore conclude," says Prof. Lapham, "that fires do not produce rain, and that Prof. Espy was mistaken in his theory on that subject? By consulting his reports (Fourth Report, 1857, p. 29), it will be found that he only claimed that fires would produce rain under favorable circumstances of high dew-point, and a calm atmosphere. Both of these important conditions were wanting at Chicago, where the air was almost entirely destitute of moisture, and the wind was blowing a gale. To produce rain, the air must ascend until it becomes cool enough to condense the moisture, which then falls in the form of rain. But here the heated air could not ascend very far, being forced off in nearly an horizontal direction

by the great power of the wind. The case therefore neither confirms nor disproves the Espian theory, and we may still believe the well-authenticated cases where, under favorable circumstances of very moist air and absence of wind, rain has been produced by large fires." Prof. Lapham also remarks, "The telegraph-wires indicated no unusual disturbance of the electrical condition of the atmosphere." Upon reading this last remark, the question occurs to us, Can there not be a change in the electrical state of the atmosphere which, although too small to manifest itself upon telegraph-wires, may occasion storms?

Some experiments made by the writer in the physical laboratory of Harvard College, on the influence of flames upon the electrical state of the air, may throw some light upon this subject. Two pieces of apparatus were used, one of them "the new quadrant electrometer" of Sir William Thomson, and the other a "water-dropper," also an invention of that distinguished philosopher. The electrometer is a very complicated piece of apparatus. Let me describe it in as clear a manner as possible. I do not know that I shall succeed in conveying to the uninitiated any idea of that instrument, for it has many parts. I shall endeavor merely to explain its principles roughly. Conceive of a light aluminum needle, suspended by two single cocoon threads in the centre of a glass jar, which is filled to nearly one-sixth of its capacity with strong sulphuric acid. A very fine platinum thread drops from the aluminum needle and dips in the acid. Let us see what we have now. An aluminum needle suspended in mid-air by two filaments of silk very near each other, and so fine that they can hardly be perceived by the naked eye. Further, this needle has an extremely fine metallic wire running down from it and terminating in a little weight, also of the metal platinum, which is immersed in the sulphuric acid. Thus we see that the needle is very free to swing in a horizontal plane, and it will be readily perceived that, if there were but one filament of silk supporting it, it might swing round a complete circumference, or indeed make many revolutions under the influence of a strong repellant or attractive force; the two filaments by their torsion allow the needle to swing only to a certain distance, and compel it to return to its original position when the force is removed. One can readily conceive of this by suspending a bar in an horizontal position by two vertical ropes, and then endeavoring to turn it in an horizontal plane.

Let us now charge the aluminum needle with positive electricity. To do this, we shall conduct into the sulphuric acid by means of a metallic wire a slight positive charge, and the acid, being a good conductor, will convey this charge by the extremely fine metallic wire to the aluminum needle suspended above the acid in mid-air. Now, if we present a substance charged with negative electricity to the needle, it will, as is well known, be speedily attracted; and if the substance presented has a positive charge it will be repelled: the unlike charges attracting and the like repelling each other. Thus, we see that we

have a very delicate test for the character of the electricity in the body which we bring into the neighborhood of the needle. But, the needle being only about two inches in length, slight movements in it can hardly be detected. How is this to be remedied? We are going to deal with delicate impulses, and it is necessary to have some means of observing them. Standing at this window, through which the sun streams brightly, with a little mirror, we can, as any school-boy knows, throw the image of the sun in almost any direction that we please. Now it rests upon the brick wall across the street, a hundred feet or more distant from us. Let us turn the glass slightly: see how small a movement suffices to make the sun's image on the wall dart over at least twenty feet! Why can we not attach a little mirror, which shall not weigh more than a feather, just above our needle, and let it reflect, instead of the sun, a little point of light from a kerosene-lamp upon yonder wall which is four feet from it? We have done so. We allow the light of the lamp to stream through a small opening in a screen of blackened paper, and to fall upon the mirror. Upon presenting this metallic plate, which has been charged with positive electricity, the spot of light darts along the scale pasted on the wall; it has gone over nearly six inches of the scale, while the motion of the needle and the mirror was hardly perceptible. We have now an extremely delicate test for the presence of electricity—so delicate that even the small charge ever present in our bodies is sufficient when we approach the instrument to make the spot of light dart to and fro. It is only necessary now to have some convenient means of presenting the body to be examined to the needle; for it will be seen that all movements of the air in its neighborhood must be avoided. To accomplish this end, we surround the needle with four plates of brass, which are carefully separated from the needle. They are in the form of sectors of a circle and lie in an horizontal plane, the suspension fibres of the needle going through a round hole in the centre of the circle of which the sectors form a part. These sectors are separated from each other at first; the opposite pairs can, however, be connected at will. It is not necessary to dwell upon their peculiar construction: their object is to prevent the charge, led to them by these copper wires, running to any part of the room, and thereby to influence the needle. It will be seen that this instrument, of which we have explained only the principal features, is wonderfully delicate, and far superior to the old electrometers which showed electrical attraction and repulsion by the divergence of two suspended gold leaves.

It remains now to describe the "water-dropper." This consists merely of a tin vessel carefully insulated at the base, with a long glass tube projecting from an orifice near the bottom. The water runs through this tube and issues in a fine stream from its end, breaking into drops about fourteen inches below it. A collecting-plate connected with one of the brass plates which we have described in the electrom-

eter stands under this stream of water. Now the drops of water in their fall upon the plate remove by their impact the charge which the plate has by itself—for all bodies have a greater or less electrical condition, and the plate then takes the electrical condition of the air in which it is immersed.

Let us place our water-dropper on the window-sill with its tube projecting into the open air; and, having placed the collecting-plate so that the drops of water may strike upon it, let us notice our little spot of light. It is a clear day in early summer; there are no clouds to be seen, save a rift away on the horizon in the west. The spot of light moves gradually over the scale, indicating that there is a slight positive charge of electricity in the atmosphere. Now it is stationary, and we are about to record the reading of the scale, when the spot of light gives a quick jump and then returns to nearly its original position. Perhaps some movement of ours has deranged the instrument. We look at it carefully, and return to our position of observation. A low rumble, as if of distant thunder, is heard. We do not mind this at first; presently the spot of light darts again along the scale, and again returns to its original position. We stand in silence, waiting for further developments. Now, we hear again a rumble, and a low muttering, as if of thunder in the west. Can this movement of the spot of light have any connection with the distant lightning? At least five minutes must have elapsed between the time of the movement of the spot of light and the moment when the thunder was heard. Again the spot moves, again follows a low peal of thunder; again and again the same phenomenon is observed. There can be no doubt of it: the electrical discharges of the approaching storm, yet miles away, are registered by this little instrument in our laboratory. Now the storm approaches nearer. We hear the wind in the trees; a few drops fall upon the tinned roof; the lightning darts hither and thither, and the spot of light leaps responsively to it.

Such, then, is the delicacy of our instrument. By allowing the spot of light to fall upon sensitive paper, which moves along by clock-work, we shall have all of its motions recorded by photography. This registration has been accomplished by Sir William Thomson, to whom we owe so many beautiful electrical instruments. It would be well if our Signal Service should make contemporaneous observations in different parts of the country by means of these instruments. Such observations could not fail to throw light upon the connection of electrical storms with rain-storms, and extend our knowledge of meteorology.

Let us now, having proved our instruments, approach the question of the influence of flames upon the electrical state of the atmosphere. Our observations must be made in the laboratory, and are necessarily of a somewhat general character from the nature of the subject. It is a cold, clear day in early winter, with the wind blowing freshly from

the northwest. We know by various indications that the air is highly electrified. The wind blows too freshly to place our water-dropper out-of-doors; accordingly, it is placed upon a table in the laboratory, and we notice the indication of the instrument. The air is indeed highly charged—the spot of light is thrown to a greater distance upon the scale than we have often noticed. Let us record the reading; it is as much as the positive pole of twelve Daniell cells gives. Now, lighting our Bunsen gas-burner, and placing it near our water-dropper, let us observe the spot of light; it does not change its position materially at first.

Now, after the lapse of a few minutes, it falls to a lower position upon the scale, now it goes down to zero. Now it mounts again, but in a contrary direction to its first indication, showing a slight negative charge in the air, which before was strongly charged positively. Can this be due to the presence of the flame? And, if it is due to the flame, are not great fires capable of influencing the electrical state of the atmosphere, to a greater or less extent? Such are the questions which force themselves upon us. We must, in the first place, examine our flame. Soldering a platinum wire to the copper connecting wire, and dispensing with the water-dropper, we examine the outer and inner cone of the flame. At all points in the luminous portion of the flame an indication of negative electricity is obtained; at all points in the immediate neighborhood of the flame, but exterior to it, there are signs of a positive charge in the heated air. The inner cone of partly-consumed gas is neutral, or slightly negative.

The flame, therefore, is negative, and it tends by its presence to reduce the positive charge of electricity which generally characterizes the air of fine weather to zero, or to change it to a feebly negative charge. We learn from various writers upon meteorology that the normal electricity of the atmosphere is positive. Herschel in his work on Meteorology says, p. 125: "Out of 10,500 observations made at the Kew Observatory in 1845–'47, 10,176 showed positive, and only 364 negative electricity—the latter being almost always accompanied with heavy rain." Sir William Thomson, in the proceedings of the Literary and Philosophical Society of Manchester, March, 1862, relates some experiments which tend to show that clearing-up weather is preceded, and in many cases foretold, by a change in the atmosphere from a negative to a positive charge of electricity.

We can, therefore, conclude with some probability of truth that great fires, by changing the electrical state of the atmosphere, have an influence upon the production of rain. The state of our knowledge, however, in regard to the part that electricity plays in atmospheric changes, is very meagre. The question of the truth of the popular belief that great fires are followed by rain still remains unanswered; and we can only hope that we have thrown a little more light upon it by our research.

## PROFESSOR TYNDALL'S TOPICS.

THAT the expectation of pleasure and profit from the course of lectures which Prof. Tyndall has prepared for delivery in this country is not likely to be disappointed, will appear from the following careful analysis of his theme, Light and Heat, as he has arranged it for six nights:

He begins in a prefatory way, and dwells upon the introduction of the experimental method into Science—speaks of the ardor of investigators and of their rewards. He seeks to show that most of them wrought for the sake of *knowledge*, and with no practical end in view, though their discoveries travelled to the most astonishing practical applications. After dwelling on the importance of original inquiry, he takes up the real subject of the lectures. The instruments are explained, and the principles upon which they depend. He points out the proximate cause and action of the electric light which is to be used in the illustrations. The laws of reflection are demonstrated, and one or two striking practical applications adduced. Then he goes on to refraction. These elementary subjects are really touched upon in order to enable him, in a subsequent lecture, to reveal the workings of Newton's mind when he theorized upon the subject of light. Refraction is followed by an inquiry into the constitution of light, its analysis and synthesis. This occupies the first lecture.

In the second lecture the demonstrated constitution of light is applied to the doctrine of colors. He goes very thoroughly and plainly into this matter, making perfectly evident the causes on which ordinary colors depend; winding up by the experimental proof that yellow and blue light, when mixed together, produce *white* and not green. Having exhausted the ordinary spectrum, he describes the difference between the emissions from solids and their vapors. Metallic vapors are produced and shown with their characteristic colors. Their light is then analyzed, and it is shown to be distinctive of the substance from which it comes. Spectrum analysis is dwelt upon, and copiously illustrated.

In his third lecture, Tyndall deals with solar light, dwelling upon the distinction between the bright lines of the metallic vapors, and the dark lines of Frauenhofer. The reciprocity of radiation and absorption is demonstrated, and it is shown experimentally that an incandescent vapor absorbs the light which it emits. This leads up to the theory of the physical constitution of the sun. Then he goes on to show the extension of the spectrum beyond its visible range, performing with quartz prisms and lenses Stokes's experiments on Fluorescence, and the rendering visible of invisible rays. Then the other side of the spectrum is handled; its extension as *heat* beyond the limits of light is

demonstrated. Numerous experiments on the *total* heating power of the rays from the electric light are made; fusion and combustion being thus effected. Here he hopes to perform the famous Florentine experiment of the ignition of a diamond in oxygen, using, however, a purely terrestrial source of radiant heat. He also hopes to produce combustion by rays concentrated by a lens of *ice*. The heat-rays are then filtered from the light-rays, and it is shown that all the foregoing effects are produced by rays totally beyond the range of vision; fusion, combustion, and explosion, being produced at foci perfectly dark, and, as far as the air is concerned, perfectly *cold*. It is also proved that these dark rays perform the work of evaporation in the tropical ocean, and the work of fusion upon the Alpine ice and snows. The rays, moreover, are shown to be competent to raise platinum to a white heat, so that by its intervention you may extract from the dark rays all the colors of the spectrum. This brings him to the end of the third lecture.

In the fourth lecture he shows the irresistible tendency of the human mind to seek for governing principles which rule facts and correct them, rendering them, so to say, organic. He dwells upon the exercise of the theorizing faculty, taking Newton as an example. He tries to show how naturally his optical theory grew out of his previous knowledge. The doctrine of colors is now extended by the introduction of the colors of thin plates, of striated surfaces, etc., and he unravels the subtle additions which Newton made in his theory, in order to fit it to these new facts. The theory of emission is then contrasted with the theory of undulation. The latter is rendered familiar to the mind by preliminary considerations regarding water-waves, and by experiments regarding sound. He dwells upon the labors of Thomas Young, and the effect of Brougham's attacks in the *Edinburgh Review*. This will be his most difficult lecture, but he has wrought hard to make it clear, and it is essential to the comprehension of the subsequent ones.

In the fifth lecture Tyndall enters upon the phenomenon of crystallization, and seeks to give an intelligible explanation of crystalline architecture. The process of crystallization is experimentally illustrated. This is done with a view to the action of crystals upon light. In the first experiments he deals with crystals solely with reference to the polarization of light. This is explained and illustrated by numerous experiments. Double refraction and the state of the two halves of the divided beam are dwelt upon. Then come the chromatic phenomena of polarized light. Basing himself upon the principles explained in the fourth lecture, he hopes to make these effects comprehensible by all intelligent persons. The effects of mechanical strains and pressures in producing a *quasi* crystalline structure are exhibited. Then the similar phenomena of unannealed glass. He hopes to show these effects in a very splendid fashion. They will more than fill the fifth lecture.

The sixth lecture is devoted to the further illustration of the action of crystals upon light; uniaxal and biaxal crystals, circular polarization, and the chromatic effects produced by rock-crystals; the conferring of double refractory power by sonorous vibrations; and the magnetization of light. Although the syllabus is short, it covers a good deal.

We have sketched the course of six lectures. The materials touched upon are ample to fill the six to overflowing, allowing an hour and a half for each lecture. A seventh very striking lecture might be given, he says, on the identity of light and heat—every experiment made in the optical lecture being shown capable of repetition with pure lightless radiant heat, the thermo-electric pile and galvanometer being substituted for the eye. He has made an arrangement for the projection of the galvometer-dial upon a screen, which renders it visible to any number of people.

As he worked at the subject, the desire grew upon him to do it more and more thoroughly, and to spare no expense as regards apparatus. He has accordingly purchased between three and four hundred pounds sterling worth of new instruments; and has gone over all the experiments, so as to render every thing sure, and in a manner worthy of the subject and of the occasion.—*United States Railroad and Mining Register.*

## THE COCOA-NUT PALM, AND ITS USES.

By C. F. LOW.

COASTING along Ceylon and the Malabar littoral, the voyager will notice the tall palm-trees, which appear as if growing in the sea, and will learn, on inquiry, that they are of the variety *Cocos nucifera*, or the loving cocoa-nut tree.

Though the sight of these never-ending groves may at length pall upon the eye of the traveller, yet he will do wisely if at eventide, while the ship is becalmed, he should take the "jolly" boat and land on the silent beach. In a few minutes he will stand in a "grove of palms," and must be of a somewhat stolid temperament if he does not feel something like a new sensation, as he looks aloft and listens to the rustle of the first breath of the sea-breeze, as it gently waves the graceful fronds or leaves overhead. Those who have been in the East will, as they read these lines, recall the sound, and with it, perhaps, may be brought to mind many pleasant days and the faces of old friends who sleep beneath the southern cross. Those who have not strolled under the welcome shade afforded by the fern-like canopy, will remember Thomson's lines:

"Sheltered amid the orchards of the sun,
Where high palmettos lift their graceful shade,
Give me to drain the cocoa's milky bowl,
And from the palm to drain its freshing wine."

There are many varieties of the palm. Among them the *Caryota urens* is the most ornamental, with its long, pendulous clusters of dark-red, succulent, acrid berries. The pith of this tree yields a species of sago, and the sap is commonly employed in the Deccan as yeast for raising or fomenting bread. There is also the travellers' palm, or crab-tree, from which a watery juice is extracted, and which, crowning the summits of hills, forms a picturesque object on the landscape, with its broad, fan-shaped leaves. The date-trees of India and Ceylon neither possess the loftiness nor the beauty of foliage of those growing in such luxuriance on the banks of the Shatt-al-Arab, in Mesopotamia, and indeed seldom bear fruit. The areca-palm, which is cultivated in most parts of India, and is indigenous on the Malabar coast, furnishes the "betel-nut," which, mixed with "paun," forms a composition which the Hindoos are in the constant habit of chewing.

There are five well-marked varieties of the cocoa-nut.[1] The Tembili, of which there are different descriptions, is a very well-formed, handsome nut, of oval form and bright-orange tint. The Buddhist priests of Southern India and Ceylon generally contrive to keep a store of the choicest kinds of the Tembili in their temples as offerings to the passer-by, who is expected to make a return. The Nawasi is slightly heart-shaped, of lighter color than the preceding, and bears an edible husk. On stripping off the outer rind, the inner skin turns to a pale-red color, and is fit for use. There is a third variety of nut, somewhat small and round, and in color much resembling the Tembili. Then there is the common cocoa-nut, so well known to every urchin; and, lastly, we have the double (*Ladoicea Seychellorum*), which, as its name implies, is a product of the Seychelles, a group of islands in the Indian Ocean.

In old times the most marvellous medicinal virtues were attributed to nuts of this description, and they were considered unfailing antidotes to all kinds of poison. As their origin was veiled in obscurity—those obtained being either caught-up floatings at sea or on the coasts of the Maldive Islands, where they were thrown up by the tides and currents—the most extravagant sums were asked and obtained for them. Thus it is recorded that the Emperor Rudolph II. offered 4,000 florins for one which chanced to be for sale, but, the bidding being considered insufficient, the precious nut passed into other hands. It is even said that a merchant-ship, with her freight and stores complete, has been bartered in exchange for one.

The natives believed that the trees producing these nuts grew at the bottom of the sea, and were enchanted palms, which vanished the instant the adventurous diver attempted to reach them. Death was

[1] "The Cocoa-nut Palm," by W. B. Lord, R. A.

awarded to any one who, having found one of these nuts on the shore, failed to make it over to his sovereign. The kernel was the part supposed to possess miraculous medicinal qualities, and with it were mixed such anomalous ingredients as pounded antlers of deer, ebony-raspings, and red-coral dust.

At the present day, when these cocoa-nuts are exported from the Seychelles Islands, cups made from the shells are mounted by the wealthy natives of India with gold and precious stones; the religious mendicants of Ceylon also set a high value on the shells, and use them as alms-boxes to attract the contributions of the faithful.

The palm bearing the common cocoa-nut attains, in situations favorable to its growth, a height of from 60 to 80 feet, but rarely exceeds a diameter, at the base, of from one to two feet. The roughness of the bark is caused by the progressive falling off of the fronds, as the tree shoots upward. But this roughness and the crookedness of the tree (for a straight palm is rare indeed) are compensated by the beauty of the foliage of the crown. "Here," says Mr. Lord, "the graceful, fern-like leaves may be seen in every stage of development—the lower tiers drooping, those above spreading out feather-like, while the centre stands up plume-like in all its beauty." The nuts grow in clusters, and the number on one tree varies from 40 to 200 in different stages of development. The "spathes," which are thrown up among the young leaves of the cocoa-palm, and on which grow the blossoms, are often nearly four feet in length and six inches in circumference. In favorable seasons these spathes or plumes of flowers are shot forth every four or five weeks, and as the blossoms drop off the young nuts are formed, affording a store of food and drink all the year round. When the sap of the palm is sought for the manufacture of toddy, or some other products, the young fronds, together with the flower-spathe, are bound together with ligatures, in order to prevent the development of the blossoms; a puncture is then made at the foot of the spathe with a toddy-knife, and numerous taps administered to the part adjoining the cut, with the handle, to set the sap flowing; a chatty, or earthen pot, is then suspended in a suitable position to receive the cool, sweet juice of the tree.

To ascend the lofty palm various methods are employed, and often has the writer watched the agile natives swarming up with rapidity by inserting the great-toe into a series of notches cut into the bark. Another method is by casting a band round both tree and toddy-drawer, who then plants the soles of the feet against the trunk, and literally walks up, "hand over fist." They also traverse the space between the top of the trees on coir-ropes, thrown across from one to the other. Early in the morning, before the sun is up, the toddy-drawer with monkey-like agility ascends the tree, lowers down his well-filled pot, which is received by a companion, who replaces it by an empty one. From one to three quarts is the general result of one

night's drawing; but the trees thus treated become barren, and yield no fruit. Immediately after collection the toddy is sweet and deliciously cool, but in the course of a few hours this is changed for an agreeable acidity. It forms a refreshing drink in this state, but in twenty-four hours becomes quite sour. Toddy, when fermented, is made into arrack, a liquor which, being cheap and fiery, is greatly consumed by the poorer class of Europeans at Bombay, and is the bane of our soldiers and sailors in the presidency town.

Vinegar is made by allowing the toddy to stand for about a month in earthen jars fitted with covers. The liquid is then carefully strained, and replaced in the jars, in which is thrown a little red pepper, a small piece of the fruit of the gamboge-tree, and a pod of the horseradish, which in the East attains the dimensions of a tree. In about five weeks vinegar of a most excellent quality is the result. Not only spirits and vinegar are made from the juice, but the material known as jaffery, or native sugar, is produced before fermentation by boiling the sap to a syrup with quicklime, when it is roughly crystallized. Large quantities of this are exported, and used for sweetmeats, in the manufacture of which in great variety the natives of India are consummate adepts.

The cocoa-nut is consumed in a greater variety of ways than even the sap, and not a portion of it, or of the palm on which it grows, is without its special use. Besides the refreshing drink extracted from the young undeveloped nut, which is also made into a dye, the pulp inside the soft crust is considered a delicacy, and is used in the preparation of various dishes. The kernel, when ripe, is also treated in a variety of ways for food, and forms an important ingredient of curry. Cocoa-nut oil is also extracted from the ripe fruit by the natives with their primitive contrivances, in which bullocks are the motive power. When under European manipulation, iron machinery driven by steam expresses about 2½ gallons from 100 nuts. Besides its more practical and prosaic virtues of supplying food and clothing, the poets of the East have from time immemorial assigned as one of the attributes of the cocoa-nut palm-tree that it "loves to hear the sound of footsteps and pleasant voices."

In moderately favorable situations, says a writer, this species of the palm commences bearing fruit at from ten to thirteen years of age, and remains at full maturity for between sixty and eighty years, producing, on an average, about 100 nuts annually. The tree then begins to deteriorate and fall off in its yield, continuing in this declining condition for about twenty years, when it ceases bearing altogether, and dies. It is curious that while in this moribund state the famous "porcupine-wood" of commerce is obtained from its trunk; so that even in death the cocoa-nut palm is man's faithful friend, and ministers to his wants.

Many are the uses to which the tree is put while in maturity. The

thatch covering the houses is made with the prepared mid-ribs of its leaves, and secured with cord twisted from the cocoa-fibre, from which also nets and fishing-lines are made. The plaited strips of the leaf supply material for baskets in which the freshly-gathered nuts are stored. Cocoa-cloth is an article of manufacture. Torches are made by twisting together a sufficient number of dry leaflets, the end of the mid-rib serving as the handle; from these leaflets, when split, mats are woven. As to the fibrous husk of the nut known as coir, its utility is without limit. Besides floor-cloths and mats, which are generally employed in this country for offices, and from their strength of texture are unrivalled, the coir is manufactured into rope, and is extensively used on board ship; and in the "country" trading-ships of India it entirely supersedes manila and hemp, as being equally strong and durable, and infinitely cheaper.

Pipes, bottles, and drinking-vessels for native use, oftentimes polished and handsomely mounted, are made of cocoa-nuts, from which the white meat is extracted, without injuring the shell, by pouring out the milk, filling it with salt, and burying it in the hot sand until the kernel is decomposed, when it is removed from one of the three holes in the "monkey's" face. Thus countless are the benefits conferred on man by the palm, forming, as it does, one of the most useful of all the gifts of Providence. The South-Sea Islanders, we are informed by those who have been among them, make books out of the leaf-strips similar to the papyrus of the ancient Egyptians. Canoes are built of the pliable planks, which, when grooved and bored, are stitched together with coir-twine, are propelled by cocoa-wood paddles, masted with a slender young palm, and rigged with coir-cordage, which carries a mat-sail; thus, ready for sea, freighted with a cargo of nuts, oil, lamp-black, vinegar, sugar, and arrack (all the produce of the palm), and finally stored with nut-food for the voyage, the sole remaining requisite to make a successful commercial venture, but one that man cannot command, is a propitious breeze.—*Food Journal.*

## HUMANITY AND INSANITY.

FROM THE FRENCH OF MAXIME DU CAMP.

IN studying the history of insanity, we are surprised to find that the same mild treatment now universally adopted was very clearly prescribed by the chief professors of medical science in the beginning of our era. Thus, Aretæus the Cappadocian recommends the use only of the supplest cords, to restrain violent maniacs, "for," says he, "to resort to any cruel measures of restraint will increase rather than allay the over-excitement." Galen was the first to maintain that all

disorders of the mental faculties are produced by a lesion of the organs of thought, which are situate in the brain. Yet we are not to imagine that in Galen's day the art of healing was faultless; indeed, so far is this from being the case, that we find his contemporaries making large use of philters, charms, and magical formulæ. In the seventh century Paulus of Ægina reasserted the principles maintained by Galen and by Aretæus; but with him the line of rational medical tradition comes to a close, and henceforth, for centuries, it would seem as if the doctors shared in the disorder which they assumed to cure. The madman was now no longer regarded as a sick patient, nor even as a human being. He was treated as a wild-beast—half brute, half demon; soon his disorder was called "satanic possession," and he himself burned at the stake.

The middle ages were a period of upheaval, when every thing was swallowed up in the bottomless abyss of scholasticism and demonology, and medicine became a routine of superstitious practices.[1] Such and such a plant was considered beneficial, if gathered at the new moon; but deadly poison, if at the moon's wane. Science, art, and literature, went down in the storm, and wars, battles, pestilence, and famine, were the order of the day. As God was invoked in vain, men turned to Satan. The belief in the devil was universal, and the world became a hell. Now both science and experience show that the prevailing notions of a given period are very rapidly taken up by the insane, and by them distorted into grotesque shapes, with a uniformity resembling the symptoms of epidemic disorders. This phenomenon is of daily occurrence. Thus, accordingly as France is ruled by a king, an emperor, or a president, those insane persons who imagine themselves to be somebody, claim the rank of president, emperor, or king, as the case may be. Just now, respectable women patients at the Salpêtrière, Ste.-Anne, Vaucluse, and Ville-Évard asylums solemnly assure the physicians in charge that they are *pétroleuses;* while men of unquestionable patriotism will tell you that they guided the Prussians up the heights of Sedan. The phenomenon therefore of diabolic possession in the middle ages is perfectly natural. The calamities attendant on continual wars had so enervated the people, that they were fit subjects for all manner of mental disorder; and this, taking form from the prevailing ideas of the times, found expression in demoniacal possession.

[1] Borden, who lived in the seventeenth century, and was a man of keen intelligence, tells us of a monk he knew, who practised bloodletting to an unlimited extent. After three bleedings, he would add a fourth, for the reason that there are four seasons, four quarters of the globe, and four cardinal points. After the fourth he took a fifth, because there are five fingers on the hand. To the fifth he would add a sixth, for did not God create the world in six days? But the number must be made seven, there being seven days in the week, and seven sages of Greece. An eighth bleeding had to follow, eight being a round number; and a ninth, because *numero Deus impare gaudet*—God loves odd numbers.

During the middle ages the devil was everywhere—*ubique dæmon*. There was one religious sect whose adepts were ever spitting, hawking, and blowing the nose, with a view to expel the devils they had swallowed. A trace of this still remains in some localities, where one who sneezes is saluted with "God bless you!" Such beliefs were universal. Thus a certain prior of a convent had around him constantly a guard of two hundred men, who hewed the air with their swords, so as to cut to pieces the demons who were assailing him. Demons were even cited to appear before ecclesiastical tribunals.—A curious and a pitiful epoch, when the possessed and their exorcists were madmen alike!

This view of insanity was favored by the philosophical, or rather the theological ideas of the time. According to these, man was of a twofold nature. On the one hand was *the flesh*, mere matter; on the other, *the soul*, a direct emanation from Deity, passing through this vale of tears, on its way to the ineffable glory of heaven. The body is but the soul's dwelling-place—a temple or a den, accordingly as its invisible inhabitant is the servant of God or of Satan. Therefore, when the soul is diseased, the treatment must regard the soul alone, which is governed by laws of its own, and is merely in juxtaposition with the body for a moment. No doubt the ideal of purity thus held up was sublime; yet the result of it was the upsetting of the body's equilibrium; and this reacted on the mind. But this theory led to still more serious consequences; for it was admitted into science, and checked the progress of the medical art. When in 1828 Broussais attacked it, he was accused of blasphemy, and of "sapping the foundations" of society. Now, however, we know that the faculties of the mind are not independent of the conditions of the body. Take a slight dose of sulphate of quinine, and you lose, for the time being, the faculty of recollection; swallow a little hashish, and you are transiently insane.

In 1453 Edelin, a priest and doctor of the Sorbonne, preached against the cruelty of putting to death poor creatures who were the dupes of their own diseased imaginations. On being cited to defend himself before a tribunal, he became suddenly insane, and was immured for life, that is, shut up between four walls, without food, drink, or light. In the sixteenth century Europe literally blazed with the fires lighted to punish witches and sorcerers, who were simply madmen. Luther had a visit from the devil. Pico della Mirandola tells of Savonarola's visions, and Melanchthon holds converse with spirits. Even Ambroise Paré, the Hippocrates of modern times, believed in possession, in compacts with the devil, and the like. The same is to be said of Fernel, famous for his calculation of the earth's dimensions, and of Bodin, the great jurisconsult. These great men, with all their sagacity, with all their learning, would seem never to have heard of the monk Bacon's dictum: "We cannot determine by speculation or by imagination what Nature will do, or what endure; all that must be

made out by experiment." When illustrious *savants* like these were firm believers in demonism, it need not cause us any surprise to see eight hundred sorcerers burnt at the stake within sixteen years in Lorraine alone, or five hundred at Geneva in three months.

The first effective blow was aimed at this superstition by Wier, a physician of Cleves, who was the true founder of mental pathology. Knowing well the temper of his time, he moved with extreme caution. He classes demons in sundry categories, and reckons their number by millions. Having thus given an exhibition of his orthodoxy, he next throws all the blame on the devil. It is he, and not the witch or the sorcerer, that is to be punished. As *possession* is simply a form of disease, the possessed should rather be treated medically than burned at the stake. Wier brings facts to show that the phenomena of possession are all explainable without supposing any diabolic interference. His was the period of the invention of printing, of the discovery of America, of the Protestant Reformation—the age of Galileo and of Kepler. It might have been supposed that the sixteenth century would have seen the end of demonism in Europe. But no; the princesses of the house of Medici brought in their train to France a horde of astrologers, necromancers, disciples of Locusta, fortune-tellers, etc. Three famous cases of possession marked the beginning of the seventeenth century: that at Labourd in 1609; that of the Ursulines at Aix in 1611; and of the Ursulines at Loudun, from 1632 to 1639.

The phenomenon of insensibility to pain is one of not very rare occurrence. This insensibility may be confined to a single member, or some particular locality, or it may extend to the whole body. During the middle ages all sorcerers were supposed to bear the mark of the devil, viz., the spot touched by the fiend when taking possession of his subject. This spot was insensible to pain, and was discovered by prodding the unfortunate culprit with a long needle, here and there, all over the body until it was found.

So general was the prevalence, among the inmates of convents, of a peculiar form of hysteria, that it got the name of *possession des nonnains* (*nonnain*, nun). Its pathology is clear: melancholia attended by hallucinations, illusions of the sense of touch, and an irresistible desire of suicide. Take the remarkable case of the nuns of Saint-Louis de Louviers (1642), which engaged the attention of the Parliament of Rouen. The principal heroine of this sad history was Madeline Bavent, who, on being shut up in a dungeon, spent four hours in endeavoring to put an end to her life, by driving a large nail into her bowels, and turning it round and round. She was clearly the subject of hystero-melancholia, but her judges decided that she was possessed of a devil. But at length the belief in demonism was forced to give way before the gradual advance of science, and in 1672 Colbert induced Louis XIV. to sign the famous ordinance forbidding the

Parliament any longer to prosecute sorcerers. But this was not until over twenty thousand individuals had perished at the stake simply for having been insane.

Thus ended what we may call the thaumaturgic era of insanity, and now follows the era of repression. There were as yet no hospitals to receive the insane, who were confined in convents or in prisons, according to the violence of their disorder. They were fettered, beaten, suffered to wallow in straw, exhibited to sight-seers, to gratify idle curiosity, or to afford amusement. This treatment was far from being such as medical science requires; but, still, it at least was a great improvement on the stake, and was less calculated than the exorcisms of the previous period to over-excite the patient. A last effort was made by the clergy and the Parliaments in 1713 to recover the powers of which they had been deprived by the ordinance of Louis XIV., but they were unsuccessful; and, consequently, when the Jansenist miracles and *diableries* became the talk of Paris, the government was content with simple measures of police repression. Finally, in 1768, the Parliaments declared that *possession* is a disease. Cagliostro was afforded every facility for summoning up the devil and putting him *en rapport* with the Cardinal Rohan; and Mesmer might now assemble at his famous banquet all the nervous subjects in Paris, without any hindrance on the part of king, clergy, or police.

Science meanwhile was not idle. While justice was growing more lenient toward the insane, the study of the principles to be applied in the treatment of insanity engaged the earnest attention of all the great physicians of Switzerland, England, Holland, Germany, Italy, and France, and the various phenomena of mental pathology were carefully described by Plater, Willis, Boerhaave, Fleming, Fracassini, Morgagni, Boissier de Sauvages, Lieutard, Lorry, and others. As regards the question of treatment, however, these learned writers nearly all fell into error, because they started out with false premises. In their time the famous theory of *humorism* held undivided sway, and according to this all disease came from the *humors*, the blood, lymph, bile, etc.; and a person was diseased to a greater or less degree, according to the higher or lower degree of crudity or of coction in which his humors were found. Hence there were two universal remedies, which were expected to answer every malady: purging and bloodletting. Violent insanity had its seat in the blood; melancholy madness, in the bile; exalted mania, in the spleen. Baglivi, who died in 1707, introduced into medicine the doctrine of *solidism*, which attributes the cause of disease to the solid parts of the body. Baglivi's writings were translated into French by Pinel, who was himself a *reformer* in the best sense of that word, and who introduced the mild treatment of the insane in modern times. In 1791 he published his "Medico-philosophical Treatise on Insanity," and 1792 was appointed physician-in-chief of the Bicêtre Asylum.

We can imagine what Bicêtre must have been when Pinel took charge—a jail, house of correction, penitentiary, and hospital, all in one; and its inmates—assassins, debauchees, sick patients, paupers, idiots—lived in fearful promiscuousness; it was, in fact, a moral cess-pool. The insane, as being no better than wild-beasts, were kept separate, shut up in pens six feet square, to which light and air were admitted only through a small opening in the door. There was a bed of loose straw, renewed every month. The patient had a chain around the waist, besides being manacled and fettered. He received neither care nor medical treatment, but was left to exhaust himself in his paroxysms, affording amusement to curious visitors, who flocked to witness the strange antics of the madmen. Pinel had the invaluable assistance, in carrying out his reforms, of a humble hospital attendant, who had himself by practical experience arrived at Pinel's own conclusions years before. "When the insane patients become too violent, what do you do?" asked Pinel. "I take off their chains, they then become quiet." Pinel ordered the irons to be struck off all the patients. Among them was an old soldier of the guards, a man of herculean strength, and a violent lunatic. The physician had his irons taken off, and then bade him remove the chains off all the other patients. The old soldier's gratitude was such that he remained for the rest of his life attached to the personal service of Pinel. As Colbert, in persuading Louis XIV. to publish his famous ordinance, had brought the thaumaturgic[1] era to a close, so Pinel put an end to the era of repression. After a protracted contest, victory declared in favor of common-sense and humanity. Esquirol followed after Pinel, and showed that the physician who would treat mental disorders, must study the various symptoms; and this he can do only by daily contact with the insane. Ferrus discovered the importance of giving to the insane employment of some kind, as a means of restoring them to a healthy condition of mind. While thus, in France, science was engaged in establishing the moral bases of the disease, Roller was founding a model establishment in Germany, on the principle of surrounding the patient with all those influences which could bring his thoughts back into their normal courses. His long experience went to show the advantage of employing opium and its derivatives in the treatment of mental disorders. These are the founders of the science of Mental Alienation: others have developed their premises and added to their teachings, but to Pinel, Esquirol, Ferrus, and Roller, the human race owes a debt of everlasting gratitude for having first opened the way.—*Abridged from the Revue des Deux Mondes.*

[1] *Thaumaturgic*, working miracles, exciting wonder.

# DRIFTING OF THE STARS.

By RICHARD A. PROCTOR, B. A.,

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FROM time to time, during the last three years, I have brought before the readers of this magazine the various arguments and considerations on which I have based certain new views respecting the constitution of the sidereal universe. In so doing I have had occasion to deal chiefly with facts already known, though not hitherto viewed in that particular light in which I sought to place them. Indeed, it is an essential part of my general argument that much that is contained in observations already made has been escaping us. In the eagerness of astronomers to ascertain new facts, they have been neglecting the interpretation of facts already ascertained.

But I have long felt that it would greatly tend to advance the new views which I have advocated, if some process of research, pursued by one of those astronomers of our day who possess the requisite means and leisure for prolonged inquiries, should confirm in a clear and decisive way some definite point of my new theories. Thus, if new observational evidence should be found in favor of my theory that the nebulæ are not external to our galaxy, or if new evidence should be obtained to show that the stars are aggregated in certain regions within our system and segregated from others; or, again, if my theory of star-drift should be confirmed by new and striking evidence, I felt that a greater measure of confidence in my analysis of former evidence would thenceforward be accorded. I had no occasion, indeed, to complain of cavil or opposition; in fact, a degree of attention had been given to the new opinions I advocated which was certainly much greater than I had looked for. But there must always be such an inertia in the general weight of opinion in favor of accepted views, that only a steady reiteration of reasoning during a long period, or else some striking and impressive discovery, can cause the weight of opinion to tend in the contrary direction.

I cannot but regard myself as most fortunate in finding the first confirmation of my views (1) coming from one of the most eminent astronomers and physicists of the day, (2) bearing upon one of the most definite and positive of my vaticinations, and (3) relating to one of the most interesting subjects in the whole range of recent astronomical research.

It will be in the remembrance of many readers of this magazine that, nearly four years ago, Dr. Huggins succeeded in showing that the bright star Sirius is travelling at an enormously rapid rate away from us. In other words, besides that rapid thwart-motion which is shifting the place of this star upon the heavens, the star has a rapid

motion of recession. In the paper called "Are there any Fixed Stars?" in the *Popular Science Review* for October, 1868, the nature of the means by which this discovery was effected was fully described and explained. It may be permitted to me to mention, also, that while Dr. Huggins's researches were still unannounced (or rather incomplete) I was so far fortunate as to indicate the possibility of employing the very method of research which Dr. Huggins was then engaged (unknown to me) in applying to Sirius. I propose here briefly to describe and explain the method, referring the reader, who desires fuller information on these preliminary points, to the paper of October, 1868, mentioned above. I am the more desirous of doing this, because I find the principle of the method not readily grasped, and that I conceive the explanation I am about to offer may remove certain difficulties not uncommonly experienced.

Conceive that a person, standing on the edge of a steadily-flowing stream, throws corks into it at regular intervals—say one cork per second. These would float down the stream, remaining always separated by a constant distance. Thus, if the stream were flowing three feet per second, the corks would be a yard apart (supposing, for convenience of illustration, that each cork was thrown with exactly the same force and in exactly the same direction). Now, if a person a mile or so down the stream saw these corks thus floating past, he could infer that they had been thrown in at regular intervals; and, moreover, if he knew the rate of the stream, and that the corks were thrown in by a person standing at the river's edge, he would know that the interval between the throwing of successive corks was one second. But, *vice versa*, if he knew the rate of the stream, and that the corks were thrown in at intervals of one second, he could infer that the person throwing them was standing still. For let us consider what would happen, if the cork-thrower sauntered up-stream or down-stream while throwing corks at intervals of one second. Suppose he moved up-stream at the rate of a foot per second; then, when he has thrown one cork, he moves a foot up-stream before he throws the next; and the first cork has floated three feet down-stream; hence the second cork falls four feet behind the first. Thus the common distance between the corks is now four feet instead of three feet. Next, suppose he saunters down-stream at the rate of a foot per second; then, when he has thrown one cork, he moves a foot down-stream before he throws the next; and the first cork has floated three feet down-stream; hence the second cork falls only two feet behind the first. Thus the common distance between the corks is now two feet instead of three feet. It is clear, then, that the person standing a mile or so down-stream, if he knows that the stream is flowing three feet per second, and that his friend up-stream is throwing one cork in per second, can be quite sure that his friend is standing still if the corks come past with a common interval of three feet between them. Moreover, he

can be equally sure that his friend is sauntering up-stream, if the corks come past with a common interval exceeding three feet; and that he is sauntering down-stream, if the common interval is less than three feet. And, if, by some process of measuring, he can find out exactly *how much* greater or how much less than three feet the interval is, he can tell exactly how fast his friend is sauntering up-stream or down-stream. It would not matter how far down-stream the observer might be, so long as the stream's rate of flow remained unchanged; nor, indeed, would it matter, even though the stream flowed at a different rate past the observer than past the cork-thrower, so long as neither of these two rates was liable to alteration.

Now, we may compare the emission of light-waves by a luminous object to the throwing of corks in our illustrative case. The rate of flow for light-waves is indeed infinitely faster than that of any river, being no less than 185,000 miles per second. The successive light-waves are set in motion at infinitely shorter time-intervals, since for extreme red light there are no less than 458,000,000,000,000 undulations per second, and for extreme violet no less than 727,000,000,000,000; but these specific differences do not affect the exactness of the illustration. It is obvious that all that is necessary to make the parallel complete is that the flow of light-waves shall reach the observer at a constant rate (which is the actual case), and that he shall know, in the case of any particular and distinguishable kind of light, what is the rate at which the wave-action is successively excited, and be able to compare with this known rate the rate at which they successively reach him. If they come in quicker succession than from a luminous body at rest, he will know that the source of light is approaching, as certainly as our observer down-stream would know that his friend was sauntering toward him if the corks came two feet apart instead of three feet. If, on the contrary, the light-waves of a particular kind come in slower succession than from a body at rest, the observer will know that the source of light is receding, precisely as the river-side observer would know that his friend was travelling away from him if the corks came past him four feet apart instead of three.

Now, the stellar spectroscopist *can* distinguish, among the light-waves of varied length which reach him, those which have a particular normal length. He analyzes star-light with his spectroscope, and gets from it a rainbow-tinted streak crossed by dark lines. These dark lines belong to definite parts of the spectrum; that is, to such and such parts of its red, or orange, or yellow, or green, or blue, or indigo, or violet portion. Thus they correspond to light having a particular wave-length. And *many* of these lines in stellar spectra are identifiable with the lines due to known elements. For instance, in the spectrum of Sirius there are four strong dark lines corresponding to the known bright lines of the spectrum of hydrogen. Thus the wave-length corresponding to any one of these dark lines is perfectly well

known to the spectroscopist from what he has already learned by examining the bright lines of hydrogen. Now, if Sirius were receding very rapidly, the wave-length corresponding to one of these lines would be lengthened; it would correspond, in fact, to a part of the spectrum nearer the red end, or the region of longer light-waves, and thus the dark line would be shifted toward the red end of the spectrum; whereas, on the contrary, if Sirius were very rapidly approaching, the dark line would be shifted toward the violet end of the spectrum. All that would be necessary would be that the rate of approach or recession should bear an appreciable proportion to the rate at which light travels, or 185,000 miles per second. For, reverting to our cork-thrower, it is clear that, if he travelled up-stream or down-stream at a rate exceedingly minute compared with the stream's rate of flow, it would be impossible for the observer down-stream to be aware of the cork-thrower's motion in either direction, unless, indeed, he had some very exact means of measuring the interval between the successive corks.

Now, the spectrum of a star can be made longer or shorter, according to the dispersive power employed. The longer it is, the fainter its light will be; but, so long as the dark lines can be seen, the longer the spectrum is, the greater is the shift due to steller recession or approach; and, therefore, the more readily may such recession or approach be detected. But, with the instrument used by Dr. Huggins four years ago, it was hopeless, save in the case of the brilliant Sirius (giving more than five times as much light as any other star visible in our northern heavens), to look for any displacement due to a lower rate of recession than some hundred miles per second (little more than the two-thousandth part of the velocity of light). What was to be done, then, was to provide a much more powerful telescope, so that the stellar spectra would bear a considerably greater degree of dispersion. With admirable promptitude, the Royal Society devoted a large sum of money to the construction of such an instrument, to be lent to Dr. Huggins for the prosecution of his researches into stellar motions of approach and recession. This telescope, with an aperture of fifteen inches, and a light-gathering power somewhat exceeding that usual with that aperture, was accordingly completed, and provided with the necessary spectroscopic appliances. Many months have not passed since all the arrangements were complete.

In the mean time, I had arrived at certain inferences respecting the proper motion of the stars, on which Dr. Huggins's researches by the new method seemed likely to throw an important light.

More than three years ago, I had expressed my conviction that, whenever the recorded proper motions of the stars were subject to a careful examination, they would confirm the theory I had enunciated, that the stars are arranged in definite aggregations of various forms—star-groups, star-streams, star-reticulations, star-nodules, and so on.

Making leisure, in the summer of 1869, for entering upon such an examination, I was led to several results, which not only confirmed the above-mentioned theory, but suggested relations which I had not hitherto thought of. Some of these results are discussed in the article called "Are there any Fixed Stars?" already referred to; others are presented in an article called "Star-drift," in the *Student* for October, 1870. The special results on which Dr. Huggins's recent discoveries throw light, were first publicly announced in a paper read before the Royal Society, on January 20, 1870.

I had constructed a chart in which the proper motions of about 1,200 stars were *pictured*. To each star a minute arrow was affixed, the length of the arrow indicating the rate at which the star is moving on the celestial vault, while the direction in which the arrow pointed shows the direction of the star's apparent motion. This being done, it was possible to study the proper motions much more agreeably and satisfactorily than when they were simply presented in catalogues. And certain features, hitherto unrecognized, at once became apparent. Among these was the peculiarity which I have denominated "Star-drift;" the fact, namely, that certain groups of stars are travelling in a common direction.[1] This was indicated, in certain cases, in too significant a manner to be regarded as due merely to chance distribution in these stellar motions; and I was able to select certain instances in which I asserted that the drift was unmistakable and real.

Among these instances was one of a very remarkable kind. The "seven stars" of Ursa Major—the Septentriones of the ancients—are known to all. For convenience of reference, let us suppose these seven divided as when the group is compared to a wagon and horses. Thus, there are four wagon-wheels and three horses. Now, if we take the wagon-wheels in sequence round their quadrilateral (beginning with one of the pair farthest from the horses), so as to finish with the one which lies nearest to the horses, these are named by astronomers, in that order, Alpha, Beta, Gamma, and Delta, of the Great Bear. Thus, Alpha and Beta are the well-known pointers (Alpha nearest the pole), and Delta is the faintest star of the Septentrion set. The three horses are called in order Epsilon, Zeta, and Eta; Epsilon being nearest to Delta. Now, when the proper motions of these seven stars had been mapped, I found that, whereas Alpha and Eta are now moving much as they would if the sun's motion were alone in question, the other five are all moving at one and the same rate (on the star-sphere, that is) in almost the exactly opposite direction. Moreover, a small star close by

[1] I include this among "features hitherto unrecognized," though Michell had already noted the fact that the stars are arranged into systems. "We may conclude," he said, "that the stars are really collected together in clusters in some places, where they form a kind of systems; while in others there are few or none of them, to whatever cause this may be owing, whether to their mutual gravitation or to some other law or appointment of the Creator."

Zeta (the middle horse), a star known to the Arabian astronomers as the "Test," because to see this star was held a proof of good eyesight, is moving in the same direction and at the same rate as Zeta and the rest of this set. And besides this star (which has also been called Jack by the middle horse), Zeta has a telescopic companion which also accompanies him in his motion on the celestial sphere.

After a careful consideration of these circumstances, and an analysis of the probabilities in favor of and against the theory that the concurrence of apparent motion was merely accidental, I came to the conclusion that the five large stars and the two smaller ones form a true drifting set. I found, on a moderate computation, that the odds were upward of half a million to one against the concurrence being accidental; and, since I had recognized other instances of concurrence not less striking, I felt that it was morally certain that these stars belong to one star-family.

The reader will perhaps not be surprised to learn, however, that before publishing this conclusion I submitted it (in July, 1869) to one who was, of all men, the best able to pronounce upon its significance —the late Sir John Herschel. I have the letter (dated August 1, 1869), which he sent in reply, before me as I write. The part relating to my discovery runs as follows: "The considerations you adduce relative to the proper motions of the stars are exceedingly curious and interesting. Of late years catalogues have gone into much detail, and with such accuracy that these motions are of course much better known to us than some twenty or thirty years ago. The community of proper motion over large regions (of which you give a picture in Gemini and Cancer) is most remarkable, and the coincidence of proper motion in Beta, Gamma, Delta, Epsilon, and Zeta Ursæ Majoris, most striking. Your promised paper on this subject cannot fail to be highly interesting."[1]

In a letter written on May 11, 1870, and referring not to another letter of mine, but to my "Other Worlds," Sir John Herschel remarked, "The cases of star-drift such as that in Ursa Major are very striking, and richly merit further careful examination."

My first public expression of opinion respecting the star-drift in Ursa Major was conveyed in the following terms: "If these five stars indeed form a system (and I can see no other reasonable explanation

[1] He proceeds as follows (the passage is removed from the main text, as relating to a different branch of the subject): "I cannot say that I am at all surprised at its being found that the average proper motions of stars of small magnitudes are not less than those of large, considering (as I have always done) that the range of individual magnitude (i. e., lustre) must be so enormous that multitudes of *very* minute stars may in fact be our very near neighbors." Compare my paper on "The Sun's Journey through Space," above referred to, which paper also deals with the point touched on in the next sentence of Sir John Herschel's letter: "Your remark on the conclusion I have been led to draw, relative to the small effect of the correction due to the sun's proper motion, will require to be very carefully considered, and I shall of course give it every attention."

of so singular a community of motion), the mind is lost in contemplating the immensity of the periods which the revolutions of the components of the system must occupy. Mädler had already assigned to the revolution of Alcor around Mizar (Zeta Ursæ) a period of more than 7,000 years. But, if these-stars, which appear so close to the naked eye, have a period of such length, what must be the cyclic periods of stars which cover a range of several degrees upon the heavens?" (From Zeta to Beta is a distance on the heavens of about 19°.) "The peculiarities of the apparent proper motions of the stars," I added, "lend a new interest to the researches which Dr. Huggins is preparing to make into the stellar proper motions of recess and approach."

But a few months later, in a lecture delivered at the Royal Institution, I pointed out more definitely what result I expected from Dr. Huggins's researches. "Before long," I said, "it is likely that the theory of star-drift will be subjected to a crucial test, since spectroscopic analysis affords the means of determining the stellar motions of recess and approach. The task is a very difficult one, but astronomers have full confidence that in the able hands of Dr. Huggins it will be successfully accomplished. I await the result with full confidence that it will confirm my views."

It will be manifest that if the five large stars in Ursa are really travelling in the same direction, then, when Dr. Huggins applied the new method of research, he would find that, so far as motion in the line of sight was concerned, these stars were either all receding or all approaching at the same rate, or else that they were all alike in showing no signs of any motion, either of recess or approach.

But in the mean time there was another kind of evidence which the spectroscope might give, and on which I formed some expectations. If these stars form a single system, it seemed likely that they would all be found to be constituted alike—in other words, that their spectra would be similar. Not, indeed, that associated stars always display such similarity. Indeed, the primary star of a binary system not unfrequently exhibits a spectrum unlike that of the small companion. But the five large stars in Ursa, being obviously primary members of the scheme they form, might be expected to resemble each other in general constitution. Moreover, since the stars not included in the set —viz., Alpha and Eta—might be regarded as probably very much nearer or very much farther away, it was to be expected (though not so confidently) that these two stars would have spectra unlike the spectrum common (on the supposition) to the five stars.

Now, Secchi announced that the stars of the Great Bear, with the exception of Alpha, have spectra belonging to the same type as the spectrum of the bright stars Sirius, Vega, Altair, Regulus, and Rigel. This result was in very pleasing accordance with the anticipations I had formed, except that I should rather have expected to find that the star Eta had a spectrum unlike that of the remaining five stars of the

Septentriones. Moreover, as the stars belonging to this particular type are certainly in many cases, and probably in all, very large orbs[1] (referring here to real magnitude, not to apparent brilliancy), the inference seemed fairly deducible that the drifting five stars are not nearer than Alpha, and therefore (since we have seen that it is unlikely that *all* the Septentriones lie at nearly the same distance) the inference would be that the drifting stars lie much farther away than the rest.

It remained, however, that the crucial test of motion-measurement should be applied.

In the middle of May last I received a letter from Dr. Huggins announcing that *the five* are *all receding* from the earth. In all, the hydrogen line called F is "strong and broad." In the spectrum of Alpha the line F is "not very strong" (so faint, indeed, Dr. Huggins afterward informed me, that he preferred to determine the star's motion by one of the lines due to magnesium in the star's atmosphere). He found that Alpha is *approaching*. As to Eta, Dr. Huggins remarked that the line at F is "not so strong or so broad" as in the spectrum of "the five." He was uncertain as to the direction of motion, and mentioned that "the star was to be observed again." He subsequently found that this star is receding. But, whereas all the five are receding at the enormous rate of thirty miles per second, Eta's recession was so much smaller that, as we have seen, Dr. Huggins was unable to satisfy himself at a single observation that the star was receding at all.

It will be seen that my anticipations were more than fulfilled. The community of recessional motion was accompanied by evidence which might very well have been wanting—viz., by the discovery that neither Eta nor Alpha shared in the motion. Moreover, the physical association between the five stars was yet further evidenced by the close resemblance found to exist between the spectra of the five stars. Dr. Huggins remarked in his letter: "My expectation had nothing to do with the above results. At the moment, I thought Alpha was included in the group, and was therefore a little disappointed when I found Beta going the opposite way."

We have at length, then, evidence, which admits of no question—so obviously conclusive is it—to show not only that star-drift is a reality, but that subordinate systems exist within the sidereal system. We moreover recognize an unquestionable instance of a characteristic peculiarity of structure in a certain part of the heavens. For, though star-drift exists elsewhere, yet every instance of star-drift is quite distinct in character—the drift in Cancer unlike that in Ursa, and both these drifts unlike the drifts in Taurus, and equally unlike the drift in Aries or Leo. Much more, indeed, is contained in the fact now placed

[1] Sirius demonstrably gives out much more light than our sun, and according to the best determinations of his distance he must (if his surface is of equal intrinsic lustre) be from 2,000 to 8,000 times larger than the sun. Vega, Altair, and Rigel, are also certainly larger and may be very much larger than our sun.

beyond question, than appears on the surface. Rightly understood, it exhibits the sidereal system itself as a scheme utterly unlike what has hitherto been imagined. The vastness of extent, the variety of structure, the complexity of detail, and the amazing vitality, on which I have long insisted, are all implied in that single and, as it were, local feature which I had set as a crucial test of my theories. I cannot but feel a strong hope, then, that those researches which my theories suggest, and which I have advocated during the last few years, will now be undertaken by willing observers. The system of star-gauging, which the Herschels did little more than illustrate (as Sir W. Herschel himself admitted), should be applied with telescopes of different power to the whole heavens,[1] not to a few telescopic fields. Processes of charting, and especially of equal surface charting, should be multiplied. Fresh determinations of proper motions should be systematically undertaken. All the evidence, in fine, which we have, should be carefully examined, and no efforts should be spared by which new evidence may be acquired. Only when this has been done will the true nature of the galaxy be adequately recognized, its true vastness gauged, its variety and complexity understood, its vitality rendered manifest. To obtain, indeed, an absolutely just estimate of these matters, may not be in man's power to compass; but he can hope to obtain a true relative interpretation of the mysteries of the stellar system. If any astronomer be disposed to question the utility or value of such researches, let him remember that Sir W. Herschel, the greatest of all astronomers, set "a knowledge of the constitution of the heavens" as "the ultimate object of his observations."—*Popular Science Review.*

## HOW WAS HERCULANEUM DESTROYED?

By M. BEULE, of the French Institute.

TRANSLATED FROM THE REVUE DES DEUX MONDES.

HISTORY points out marked differences between Herculaneum and Pompeii. The first, settled by the Greeks, was devoted to intellectual culture and refined leisure; the latter, of Oscan origin, concerned itself solely about commerce; one was inhabited by Romans of fortune, and loaded with favors; the other endured the hostility of Rome, and often incurred her chastisement. There is reason to believe that Herculaneum gave a model for many details of civilization to Pompeii, and we may safely assert that Pompeii taught Herculaneum nothing. Besides, the earthquake which was so fatal to

[1] This is a work in which telescopes of every order of power would be useful. The observations, also, would be very easily made and would *tell* amazingly.

Pompeii in the year 63, under Nero, did Herculaneum no injury; so that there a part of the buildings anterior to the empire, and houses of earlier style, which implies purer taste, must have been preserved. This conclusion is strengthened at the present day by the beauty of those objects collected at Herculaneum, and will be settled beyond question whenever the city itself shall be restored to light.

What was the fate of Herculaneum during the eruption of A. D. 79? What special phenomena were displayed on that side of Vesuvius? What causes buried a flourishing city in an instant out of sight of the inhabited world? It has been proved that Pompeii suffered an interment so incomplete that after a few days its inhabitants could recognize their dwellings, could encamp above and clear them out; Herculaneum, on the contrary, was buried so deep that the next day it was impossible to trace a vestige of it. The ready answer to all these questions usually is: "Lava worked all the ruin. Herculaneum was swallowed up under eighty feet of lava. If works of art, bronzes and pictures have been miraculously preserved, it was due to the impenetrable shield of lava, yielding only to a cutting tool, that protected them from the ravages of time." The explanation is tempting. Fancy pictures waves of fire rolling upon the city, rising like the tidal swell, surging in through doors and windows, sweeping around and moulding every thing, then slowly cooling, and preserving for posterity treasures that labor must unveil, repaid by their recovery in unharmed beauty.

This is really the opinion that all Europe holds, and even at Naples almost all visitors of Herculaneum declare that they have touched the lava with their own hands; and, in books written on the Vesuvian cities, more than one traveller affirms as positively that the difficulty of cutting the lava presents the chief obstacle to the disinterment of Herculaneum. How can one venture to meet such convictions by asserting that water, not fire, overwhelmed Herculaneum; that it was not a torrent of glowing lava, but a flood of mud and wet ashes that filled the city? How uproot a prepossession so deep that the works of geologists and *savants* have failed to shake it? Dufrénoy proved that water alone swept over Herculaneum heaps of scoria and pumice crumbled from La Somma; Dyer, Overbeck, Ernst Breton, and others, have affirmed in various languages, to no purpose, that nothing but ashes, wet to paste and hardened by pressure, covered over Herculaneum: no one heeded them, and the blame continues to be thrown on the lava, which makes excavation so costly and laborious.

But every one knows the nature and effects of lava. Lava is an incandescent mass, of so high temperature as to absorb and melt all fusible bodies; forced out from the fissures of the crater by irresistible expansive power, this mass rolls on in a fiery river, burning up every thing in its path; cooling slowly, it grows as hard as porphyry or adamant. Now, I appeal to the recollection of all who have ascended

Vesuvius during those lava-flows that succeed an eruption, and continue for weeks or months even. What happens to-day, if studied with a little good sense and reflection, can enlighten us on what must have happened eighteen centuries ago. For instance, we have seen how slow lava-currents, remote from the vent of escape and cooled by contact with the ground and air, flowing around country-houses, level and consume them, with a sudden flaming up of roofs and floors. How could the stuccoes and the marble statues of Herculaneum remain unharmed, in their original color, free from crack or splinter, if they had been enveloped in lava? We have seen metals by mere contact melt and vanish in that viscous paste, which glows like fused iron or glass gushing from a furnace. How, then, do we find in Herculaneum articles of silver, bronze statues, leaden vases, with their shapes, their relief, their ornaments and polish uninjured? The bronzes of Herculaneum are even better preserved than those of Pompeii, being distinguished by their freshness of surface, their lustre, and dark and even tone, while the Pompeian bronzes have been attacked by sulphurous fumes, and eaten on the surface, and have taken on an agreeable ultra-marine blue tint, like that of sulphate of copper.

Other facts of the same kind are quite as puzzling. The guides amuse strangers with an experiment: breaking off a bit of lava with an iron-pointed stick, they let it cool on the ground, and stamp a penny on it, to get an impression of the coin. If the trial is made too quickly, the copper melts, and the coin, instead of leaving its image, disappears and mingles with the rest of the lava. How, then, do we find at Herculaneum so many ancient silver or copper coins, not merely undestroyed, but not even changed, by those waves of lava which attain a concentrated heat beyond all measurement? We know, too, that the ancients used colors with a mineral base in decorating their buildings; they will stand dampness from the earth, but the touch of fire changes their nature; the partial fires that have left traces in Pompeii have in some places altered the blue to gray, and the red to yellow, and Neapolitan artists in our time well understand the very simple method of producing what is called burnt-yellow, by exposing minium to the action of fire. How, then, do the houses uncovered at Herculaneum present such exquisite colors? How is it that the ultra-marine blue and the vermilion-red, covering whole walls, keep a freshness and smoothness that contact with a burning substance must necessarily have destroyed? Then, too, on Vesuvius I have seen trees just touched by the lava-flow take fire like matches, throw out a blazing jet, and fall at once, as if struck with lightning. Why have the beams and floors and sills of Herculaneum, instead of crumbling into ashes, slowly decayed in their places in the bosom of the earth, leaving no holes nor fractures? Why are they found blackened like oak-timbers that have been sunk in the mud for ages, like the piers of bridges and the piles of old docks at Carthage, and the wood brought down by the Jordan

and thrown out by the Dead Sea, saturated in it with chloride of sodium? How is it that every thing proves their decomposition to come only from the effects of time? How has the wood kept its character and color in those parts pierced by spikes and nails, in other words, protected from dampness by iron rust? How do we find manuscripts written on the soft fibres of papyrus-reed, when lava must infallibly have consumed them, and dispersed their ashes like those of a sheet of paper thrown on burning coals? Why has this kind lava, in like manner, respected fruits, nuts, almonds, linen, silk, lamp-wicks found in hundreds, and so many very combustible articles which have merely turned black, when they usually vanish, without the least trace, in the feeblest flame?

This refutation by absurdity might be urged with multiplied arguments. Indeed, very slight reflection suffices to show that fire could not have played any part in the destruction of Herculaneum, and that if lava, the most terrible destroying agent next to lightning, had made its way into the city, we should scarcely recognize a few blackened stones, smashed bricks, and calcined marbles. But, to say all in a word, I state that on a late tour I examined the ground of Herculaneum, in the parts made accessible by excavation, with particular care. I could not find a square inch of lava! Every thing is ashes, nothing but ashes, and these ashes have been hardened by three agents—water, pressure, and time. It is exactly this hardness, which is not to be conceived of as very great, that has deceived visitors, particularly in the underground galleries dug out in exploring the theatre. The descent is by stairways damp with exudations from the streets of Portici; overhead is heard the rolling of vehicles; we pass through tunnels polished with rubbing; we see on the smoky arches the smudge of torches, collecting for centuries; we shudder at the appalling gloom, and seem buried in the bowels of the earth. In a word, the passage impresses the imagination as strange and awful, and we reassure ourselves perforce with the thought that these galleries are hewn in lava, and beyond danger of caving in; but a scratch of the nail on this supposed lava betrays the fact that it is friable and yielding, being only hardened ashes. In one of these tunnels, which are pretty regularly cut out, the guides show the print of a human face. We wonder at the unchanging solidity of a substance which once so finely moulded the objects it surrounded. Still, if you try to cut with a knife, not into the impression itself, but into the parts next it, you are amazed to find that nothing is easier, and that it is all mere solidified ashes.

One street of Herculaneum, in the outskirts, on the side nearest the sea, has been regularly excavated, and several houses cleared out—that called the house of the skeleton, the house of Argus, some shops, a slave-prison, and others—all is in the open air, and one can walk as in the streets of Pompeii. The space thus disentombed is from 3,000 to 4,000 square yards, a large-enough area for observations of the

kind we are pursuing. Now no fragments of lava, not a vestige of it, are to be found there, nor any trace of injury caused by lava. On the contrary, on examining the perpendicular surfaces surrounding this four-sided space, every thing is ashes; 30 or 36 feet deep of ashes; only at the upper part a few bits of coal are seen, ejections from the volcano, layers corresponding with the modern eruptions, and separated by layers of vegetable earth which have had time to be deposited between the several eruptions. Look at the fragments of stuff dug out of one of those caverns—examine them—you will still find nothing in them but ashes, broken up by the pick as readily as clay or pumice.

But it may be asked, How could ashes which are light as dust, and with no coherence, gain hardness enough to take durable impressions, to form supporting arches, and to bear so delusive a look of solidity as to be taken for lava? The ready answer is found in the example of Pompeii, and the casts found in the cellars of Diomed's house; but similar and even more striking cases may help us to understand such power of adhesion. In the valleys of Monte Cavo there are ledges of *peperino*, formed by the filling up of volcanic ashes mingled with water. This compost grew so dense that the Romans used it for building-material. The Catacombs of Rome, which are nothing else than a volcanic tufa, that is, sand and pulverized fragments, compressed by time and their own weight, are in like manner friable, easy to cut, easier to rub down, and yet galleries are dug in them, arches, ceilings, stairways, numberless tombs, and as many as five stories of excavations, beneath each other! Nor must it be forgotten that pumice, which furnishes so excellent a water-lime, was taken originally from Pozzuola, near Vesuvius, and is nothing more than a ferruginous clay, once subjected to high volcanic temperature, and ejected in a shower of ashes. I recall, too, the great altar at Olympia, described by the traveller Pausanias, which was formed entirely from the ashes of the victims sacrificed to Jupiter. After every sacrifice the priests moistened the ashes with water from the Alpheus, smeared the altar with them, and so enlarged it gradually until, during ten centuries, the structure gained 125 feet in circuit, and 22 in height. Indeed, any one who has seen water flung into a fireplace may judge of the toughness of ashes when mixed with liquids; much more must the volcanic ashes of the Roman Campagna, of Naples and Santorin be suited for making cements.

For the rest, should this explanation only half satisfy the reader, there are the facts, and not to be denied. I defy any careful observer, examining the parts of Herculaneum hitherto brought to light, to discover any thing else in them than ashes. It may be that, on the surface of the existing soil of Portici, which has been raised at least 60 feet, marks of lava-flows are traceable which belong to modern eruptions, especially toward Resina. Neither can I affirm that, in some unexplored quarter of Herculaneum, the presence of lava may not some day

be ascertained; but, as the present question is only about what we know, that is, the parts of the city which are visible, or examined already, I repeat that not the hundredth part of a square yard of lava can be found at Herculaneum, and that ashes are the only thing there is there.

The problem to be solved is, how so huge a mass of ashes was ever piled up above the unfortunate city, and, since water played so fearful a part in the catastrophe, whence that enormous quantity of water came. It is clear, in the first place, that these ashes were thrown out by the volcano. Judging from the character of the region, and from the vents formed at the mouth of the crater, the pumice-stones were all hurled toward Pompeii and Stabiæ, while the ashes drifted toward Herculaneum. Perhaps some allowance must be made for the wind which separated these substances, and the convulsions which ejected them irregularly. Then we must recollect that every very violent eruption is attended by steam produced by the sudden contact of fire with underground sheets of water. The origin of these sheets of water and the effect of their sudden gush into the furnace of eruption have been already explained. These vapors, exceeding the power of calculation in their volume and expansive force, condense at once on contact with the atmosphere; they cool, and fall again in torrents of rain. If M. Fougiré could demonstrate that in 1865, during an eruption by no means extraordinary, there fell on the mountain, in 24 hours, 22,000 cubic metres of water, the number must be multiplied by five, or even by ten, to represent that explosion of Vesuvius, A. D. 79, whose fury has never been equalled. Without adopting the hypothesis of mud-discharges from the crater, or citing the example of the volcanoes in Java, which eject mire instead of water-spouts, we may affirm that such volumes of water, mingling with the ashes and pulverized substances thrown out by other vents, suddenly produced a liquid compost, either in the air or on the ground they fell upon. The Neapolitans are familiar with a phenomenon of this sort, occurring more than once, though under limited conditions. They call it "muddy lava," and their use of the substantive would be correct if they always added the adjective, in saying that Herculaneum was buried under lava. Herculaneum, in fact, was buried by muddy lava, or, in simpler terms, by torrents of mud.

Moreover, these sudden rains, or, rather, deluges, pouring down from the sky at each outburst of steam, swept along all the ashes that had fallen on the slopes of the mountain, and carried them down upon the plain; an ash-avalanche rolled over Herculaneum. At the same time, the rivers, which ran to the right and left of the city, ceased to flow down to the sea. It has been explained how the coast was elevated, and Pliny's ships kept off, by sudden new shoals preventing access to the port of Resina. The effect of this lifting was to raise the mouths of the two rivers, and throw back their waters on the city, and this overflow added its share of mud, ashes, and vegetable matter. Nor must we omit the canals filled up, the sewers choked, the aqueducts

shattered by the earthquake, and pouring their contents into the valley. By degrees, as the mud settled in the streets, the courts, rooms, and dwellings, the level of the water rose, new deposits gathered; the ashes falling in dense masses from the sky, grew saturated, and increased the rising heaps. Thus, in a few days, perhaps a few hours, a flourishing city was swallowed up, under an average thickness of sixty feet of mud. Those of the inhabitants who did not take flight at once, were drowned. In vain they climbed to the upper stories, then to the terraces and roofs—they perished at last, leaving the impressions of their bodies in the fluid ashes.

When the waters had drained away, nothing was to be seen but a grayish hillock, seamed on the surface by the streamlets which had been the last to dry up. Nothing rose above the surface, neither temple-façades, nor theatre-walls, nor tops of the loftiest buildings. Under a shell which would harden and thicken every day, Herculaneum was buried far otherwise than Pompeii had been. It was not fifteen feet of pumice stones that filled the ground floors and first stories of the houses up to the windows; it was 70 or 80 feet of compact matter that hid even the site of the city. The inhabitants who escaped must afterward have returned, as the Pompeians did; but, less fortunate, they could not revisit their homes, buried beneath their reach in unknown depths, without a trace to indicate them. Signs of excavation are thought to have been detected outside the city, above the rich villa in which the moderns have recovered 1,756 rolls of papyrus, but the owners did not dig deep enough, and their attempt was fruitless, as is proved by the art treasures discovered a century ago, which they would not have failed to carry away. It is likely that the chief impediment to digging, next to the depth, was the moisture of an alluvial deposit, in which any work soon became impossible.

But after sixteen centuries the moisture had evaporated, and the muddy lava at this day is compact and resistant enough to permit excavations in all directions throughout it. The surface has been restored to cultivation and covered with houses; Portici and Resina are populous and flourishing towns. New eruptions wrapped Herculaneum in a thicker pall, and it seemed forever blotted out from the world, until, in 1684, a baker, in digging a well, came upon ancient ruins—those of the theatre—and brought the buried city again to light.

## SKETCH OF GENERAL SIR EDWARD SABINE.

WE furnish our readers this month with an excellent likeness of the venerable President of the Royal Society, England, who will have a permanent and distinguished place in the history of science through his researches on terrestrial magnetism, of which he may be regarded as the pioneer explorer. He is of Irish ex-

traction, though descended from an ancient Italian family, and was born in October, 1788. He entered the army, and became second-lieutenant at the age of fifteen, captain at twenty-five, colonel at sixty-three, major-general in 1859, at the age of seventy-one, and was created Knight-Commander of the Order of the Bath, in 1869, at the age of eighty-one. During the war with the United States he took part in the campaign of 1814, on the Niagara frontier, when he commanded the batteries at the siege of Fort Erie. He first became known to the public by the part which he took in the Arctic Explorations in 1818–'19. He here made a series of magnetic observations of great value, an account of which was published in two papers, which he communicated to the Royal Society on his return. These and other papers, printed in the Philosophical Transactions, demonstrated several new and important facts relative to the variations of the magnetic needle, and it was the results of the observations in these northern voyages which gave the first great impulse to the systematic study of the phenomena of terrestrial magnetism. The strong desire of continuing the investigation of this and other branches of experimental physics, prompted him to undertake a series of voyages to places between the equator and the north-pole, making at each point observations on the length of the seconds-pendulum, and on the dip and intensity of the magnetic needle. The fruits of these labors were of high importance, and were published, along with other information, in 1825, and from this period his history is that of a studious investigator into the laws of and phenomena of Nature. In 1827 he was chosen secretary of the Royal Society, which office he filled until 1830. In 1836 he communicated to the British Association at Bristol his observations on the declination and intensity of the magnetic force in Scotland, and to the same Association he delivered at Liverpool a report on the variations of magnetic intensity at different parts of the earth's surface. His labors have led to the discovery of the laws of "magnetic storms," of the connection between certain magnetic phenomena and the changes of the solar spots (already referred to), and of the magnetic action of the sun and moon on the earth. General Sabine deserves almost the sole credit of extending the body of known facts in magnetic science, by the establishment of magnetic observatories in all parts of the world, and the collation of the enormous mass of facts thus acquired. He has contributed, to various scientific societies, numerous papers which display great powers of research. He edited Mrs. Sabine's translation of Humboldt's "Cosmos," published in 1849–'58.

Colonel Sabine was elected Fellow of the Royal Society in 1818, and President of the British Association for the Advancement of Science, at its Belfast meeting, in 1852. He succeeded Sir Benjamin Brodie, as President of the Royal Society, in 1861, and continues to discharge the duties of this office, at the advanced age of eighty-four.

# EDITOR'S TABLE.

### *SOCIOLOGICAL SCIENCE IN ITS LATER STATEMENTS.*

THAT man, as an individual, exemplifies the action of law in the various parts of his nature, and is hence the subject of science, everybody now understands: but that men collectively, or in social relations, are governed by natural laws which are capable of scientific investigation, is only beginning to be seen and admitted. If there are natural laws which determine the social state, it is certainly of the highest importance that they should be known. Legislation, philanthropy, and all projects of social amelioration and reform, must be but futile and quackish expedients, so long as men are ignorant of the natural forces, and orderly method, by which human society has been originated and is regulated. Social phenomena have their laws like all other phenomena, and it is the sole business of science to elucidate and declare them. Science has no schemes to propose, no reforms to carry out. Whether society is bad or good, rude or cultivated, getting better or getting worse, developing or perishing, it is all the same: science simply takes note of the facts, and draws from them the general principles to which social changes conform, and the systematic statement of which constitutes true social science.

It is from this point of view that the subject has been approached by Herbert Spencer, who is now acknowledged to be the foremost living expositor of pure scientific sociology. Some confusion has arisen in the public mind in regard to the various works bearing upon this subject which he has undertaken, and for the benefit of those interested we propose to explain his method of dealing with it, as this may prove instructive in relation to the character of the inquiry itself.

Mr. Spencer was attracted to social studies in his youth. His first publication was a pamphlet on the proper sphere and functions of political government, and his first book was a treatise on society, known as "Social Statics." It was a work of great originality and power of statement, and its fundamental idea was that of his present philosophical system, the idea of evolution; but it was only imperfectly worked out, and the effect upon Mr. Spencer's mind of preparing the volume was to convince him that the whole question of the natural laws of society would have to be taken up in a more thorough and comprehensive way, before the requirements of science could be satisfied. As society is made up of men, its deepest laws must be derived from the natures of men. The first thing to be done, therefore, was to inquire what there is in the constitution of human nature which must be known, before social effects can be understood. Man's nature is twofold, vital and psychical; and all social phenomena are phenomena of life and thought, which determine human actions. The laws of life give rise to the science of Biology; the laws of thought and feeling, which depend upon life, give rise to the science of Psychology; and a knowledge of these subjects forms the indispensable basis of Sociology. So clear and close is this dependence, and so comprehensive and complex the investigation, that Mr. Spencer soon saw he must give his life to it, if it was to be adequately done. He accordingly laid out his plan of work in 1859, and commenced its execution in 1860, allowing twenty

years for its completion. His first volume was preliminary, and contained an exposition of his method, under the title of "First Principles." Then followed two volumes of the "Principles of Biology," which was succeeded by two volumes of the "Principles of Psychology." This work is just finished, and takes him half through his undertaking. He has now before him the subject of Sociology, which he proposes to treat in three volumes of the "Principles of Sociology," to be commenced this winter. His Philosophical Series will be completed by two additional volumes of the "Principles of Morality," as deduced from the whole system of facts and principles established in the preceding works.

At this stage of his enterprise, Mr. Spencer encounters certain difficulties which have to be met by what we may call side-undertakings—works which have an important bearing upon the subject of Sociology, but are not properly parts of his philosophical system. The articles that are appearing in THE POPULAR SCIENCE MONTHLY, and which, when completed, will form a volume of the International Scientific Series, are designed to explain the nature, scope, and claims of Social Science. Such are the general doubt and misapprehension regarding this subject, that Mr. Spencer was induced to pause for a little at this stage of his labors, and present some considerations of the method and subject-matter of Sociology which are greatly needed by the public, and which do not properly fall within the course of his regular exposition. It is important to make this explanation, as the papers we have published have been supposed, by some, to be a part of his long-expected "Principles of Sociology."

Another of the difficulties of his undertaking was foreseen by Mr. Spencer several years ago, and has led to a separate work, which, though indispensable to the main plan, is nevertheless of independent value, and of great public importance. As the scientific character of his philosophy is fundamentally inductive, the first work in each department is the collection of data on which inductions are to rest. The data of Biology are accessible in treatises on Natural History, where they can be obtained in a digested and authentic form, while any defects may be supplied by special investigations. The data of Psychology are also available in scientific works upon that subject, and the conditions for extending and verifying them can be commanded anywhere. But, as respects its data, Sociology is very different from these sciences. Dealing with the phenomena manifested by diverse races and communities of men; dealing with the development of society, which is a problem of history; dealing with those facts of the social state which illustrate its natural laws; and dealing, moreover, by a scientific method, with a great subject which has hitherto been regarded as not amenable to that method, the difficulty of gathering the indispensable and pertinent facts for such an inquiry was formidable. History has occupied itself with quite other things than the record of such facts. Travellers fill their pages with chaffy gossip and egotistical narrative, and give but little attention to the social facts which it is most desirable to know. Their observations are careless, and their statements loose and often untrustworthy. Nobody has taken pains to collect and sift from the vast mass of historical rubbish and the bulky litter of travellers the few and scattered statements which throw light upon the laws of social life. Before there can be a science of Sociology presenting the generalizations of social phenomena, there must first be an accumulation and a classification of its data. What these are it is important to understand, and, in a remarkable passage of a review article published

by Mr. Spencer in 1859,[1] he thus states them:

That which constitutes History, properly so called, is in great part omitted from works on the subject. Only of late years have historians commenced giving us, in any considerable quantity, the truly valuable information. As in past ages the king was every thing and the people nothing, so, in past histories, the doings of the king fill the entire picture, to which the national life forms but an obscure background. While only now, when the welfare of nations rather than of rulers is becoming the dominant idea, are historians beginning to occupy themselves with the phenomena of social progress. The thing it really concerns us to know is, the natural history of society. We want all facts which help us to understand how a nation has grown and organized itself. Among these, let us of course have an account of its government; with as little as may be of gossip about the men who officered it, and as much as possible about the structure, principles, methods, prejudices, corruptions, etc., which it exhibited: and let this account include not only the nature and actions of the central government, but also those of local governments, down to their minutest ramifications. Let us of course also have a parallel description of the ecclesiastical government — its organization, its conduct, its power, its relations to the State; and, accompanying this, the ceremonial, creed, and religious ideas — not only those nominally believed, but those really believed and acted upon. Let us at the same time be informed of the control exercised by class over class, as displayed in social observances — in titles, salutations, and forms of address. Let us know, too, what were all the other customs which regulated the popular life out-of-doors and in-doors, including those concerning the relations of the sexes, and the relations of parents to children. The superstitions, also, from the more important myths down to the charms in common use, should be indicated. Next should come a delineation of the industrial system: showing to what extent the division of labor was carried; how trades were regulated, whether by caste, guilds, or otherwise; what was the connection between employers and employed; what were the agencies for distributing commodities; what were the means of communication; what was the circulating medium. Accompanying all which should be given an account of the industrial arts technically considered: stating the processes in use, and the quality of the products. Further, the intellectual condition of the nation in its various grades should be depicted; not only with respect to the kind and amount of education, but with respect to the progress made in science, and the prevailing manner of thinking. The degree of æsthetic culture, as displayed in architecture, sculpture, painting, dress, music, poetry, and fiction, should be described. Nor should there be omitted a sketch of the daily lives of the people — their food, their homes, and their amusements. And, lastly, to connect the whole, should be exhibited the morals, theoretical and practical, of all classes, as indicated in their laws, habits, proverbs, deeds. These facts, given with as much brevity as consists with clearness and accuracy, should be so grouped and arranged that they may be comprehended in their *ensemble*, and contemplated as mutually-dependent parts of one great whole. The aim should be so to present them that men may readily trace the *consensus* subsisting among them, with the view of learning what social phenomena coexist with what others. And then the corresponding delineations of succeeding ages should be so managed as to show how each belief, institution, custom, and arrangement, was modified, and how the *consensus* of preceding structures and functions was developed into the *consensus* of succeeding ones. Such alone is the kind of information, respecting past times, which can be of service to the citizen for the regulation of his conduct. The only history that is of practical value is, what may be called Descriptive Sociology. And the highest office which the historian can discharge is that of so narrating the lives of nations as to furnish materials for a Comparative Sociology, and for the subsequent determination of the ultimate laws to which social phenomena conform.

In this statement of the missing elements of history, Mr. Spencer has outlined just that body of facts which are indispensable as the foundation of a valid social philosophy; and he foresaw that, before any such philosophy can be constructed, these facts must be systematically and exhaustively supplied. The labor of their careful collection could not fail to be enormous, and its expense, together with their

[1] "What Knowledge is most worth" (*Westminster Review*).

publication, heavy; yet it was essential to the completeness of his system and of immense importance to the progress of knowledge, and Mr. Spencer did not for a moment hesitate to undertake it. He first devised a system of tables suited to present the whole scheme of social facts, displayed by any community, in such a manner that these facts can be compared with each other at a glance, while the social elements of different communities can also be brought into comparison with the greatest facility. These Sociological Tables are marvels of analytic skill, simplicity, and comprehensiveness; and the command they give over the results of investigation is commensurate with the greatness of the subject to which they apply.

Having fixed upon a method of presentation, Mr. Spencer divided the communities of mankind into three great groups: the existing savage races of Asia, Africa, and America; the existing civilized races of Western Europe; and the extinct civilizations of Egypt, Palestine, Greece, Rome, and Peru. Five years ago he engaged an able scholar—a graduate of the University of Edinburgh—to devote himself to the study of the savage races, and gather from all the most reliable sources the facts relating to their social state. The Tables are then gradually filled in, and each one becomes a summary, we might almost say a map, of the social condition of the community to which it is devoted. The first volume of the Sociological Tables will embrace descriptions of some seventy or eighty of the principal savage tribes, and will be accompanied by an octavo volume of extracts from the authorities consulted, and on which the summary of the Tables rests. This portion of the undertaking is now nearly completed. Another able scholar—also an Edinburgh graduate—has been for some years engaged upon the existing civilizations, the results of which will be published in a second volume of Tables and the second accompanying volume of authorities, and this work is also well advanced. A German historical student has also taken up the extinct civilizations, and will prepare the third volume upon this division of the subject. We shall thus have the full realization of what Mr. Spencer pointed out many years ago, in the above-quoted extract, as a great desideratum, and which will create the new and important science of Descriptive Sociology. It is hardly necessary to say that such a work will stand upon its own merits, and have a general usefulness that will no way depend upon Mr. Spencer's philosophical doctrines.

### *A CORRECTION.*

Mr. Editor.—In one of the late numbers of your periodical, I observe that you say, in casually alluding to my Chicago Address, that I treat the doctrine which classes mental and physical forces in the same category as being "heretical." There is but one sense in which the word "heretical" can be properly understood, or even understood at all—and that is, the sense of opposition to the prevailing religious belief. Understanding the word in this sense, there can be no difference of opinion whatever, among any of the parties to this discussion, as to the "heresy" involved in the doctrine in question. The doctrine is as much heretical in your view, and in Mr. Herbert Spencer's, as it is in mine.

But, the inference which the reader is left necessarily to draw from your remark is, that I attempted to controvert the doctrine, *on the ground* that it is heretical—a thing which I did not do at all. I did not even, if I remember aright, take the trouble to remark that the doctrine *is* an heretical doctrine, that being a thing so obvious that it may be allowed to "go without saying." My actual argument was that, in assuming the equivalency and convertibility of mental and physical forces, we are una-

voidably led to conclusions which contradict (not *religious dogmas*, of which I said not a word, but) well-established principles of Physics themselves.

Your reference to my Address was so casual and slight, that it may hardly seem sufficient to justify this seriousness of remonstrance, but, slight as it was, it placed me wholly wrong before the readers of the MONTHLY, the greater number of whom have probably not seen my Address.

I am, very respectfully,

F. A. P. BARNARD.

COLUMBIA COLLEGE, *October* 9, 1872.

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## LITERARY NOTICES.

A HANDBOOK OF CHEMICAL TECHNOLOGY, by RUDOLF WAGNER, Ph. D., Professor of Chemical Technology at the University of Wurtzburg. Translated and edited from the eighth German edition, with Extensive Additions, by WM. CROOKES, F. R. S.

TECHNOLOGY is the term now generally applied to the applications of the principles of science to the arts of industry. The earth in its matter and its forces is a treasury of material for the service of humanity. These materials furnish the aliment by which our bodies are daily nourished, the textures with which we are clad, the buildings that shelter us, and the innumerable objects of use and pleasure that minister to the service of civilized man. The transformations of matter constitute the great business of mankind in all stages of its development. In the lowest stage they are few in number, crude and imperfect in form, and wasteful both of material and of power applied. Nothing is understood, and blind groping leads to scanty and uncertain results. For every particle of matter is bound in the meshes of inexorable law, and the sole condition on which refractory Nature can be conquered and put to use, is that of knowledge. Science creates this knowledge, and thus becomes the guide of industry. The office of science in directing the operations of labor is now the great fact of civilization, and it is daily becoming of more importance to all classes of the community. Processes are daily becoming more expeditious and more perfect; the uses of things are more extended; new objects of value are created; waste-products are utilized; and the economy of effort in production vastly augmented. There is still great deficiency of scientific knowledge on the part of artisans; but large manufacturing establishments have their scientific directors and advisers, while the movement for extended technical education is participated in by all the leading nations of the world.

Technology, though always grounded in science and starting from it, is not in itself a science like astronomy or mechanics, that is, a body of inductive truths applying to specific divisions of natural phenomena, nor is it mainly concerned with true scientific work which is the elucidation of the laws of phenomena. It begins where science leaves off, or rather at the highest point which it has attained, and turns scientific results to practical account. Nevertheless, technology is by no means passive in the research after new truths. Its office being to carry out, or to verify, on a comprehensive scale, the results of pure scientific investigation, it cannot fail to react powerfully upon the work of original investigation. It is constantly putting questions, wanting further explanations, and demanding more light; and by thus forcing tangible problems upon the scientist, under pressure of great interests involved, it both stimulates research and furnishes the experimenter with what he most wants—a definite subject to be worked out. The peril of the technologist of falling into routine, and following blind rules, is thus constantly checked and more or less counteracted by the influence of his own difficulties, and the need of frequent appeal to those whose business it is to explain them.

The raw materials of Nature, which require transformation before they can be available for human use, take two routes to this destination. They either go by the mechanical way, or by the path of chemistry, and so we have two kinds of technology —mechanical and chemical. Mechanical technology deals with the outward changes of natural products, or alterations of form only, as, for example, the joiner and carpenter working in wood; the making of iron

rails, sheath-metal, and wire; the casting of iron, zinc, and alloys of copper, into various objects; the spinning and weaving of various fibres, flax, cotton, jute, to become materials of greater value; also the manufacturing of paper from rags, of horn into combs, and of bristles into brushes—all these operations belong to this section.

Chemical technology, on the other hand, as Dr. Wagner observes, "deals with the operations by which the raw material is not only changed in its form, but especially as regards its nature; such, for instance, is the case with the extraction of metals from their ores; the conversion of lead into white-lead and sugar of lead (acetate of lead); the conversion of sulphate of baryta into chloride of barium and baryta white (permanent or Chinese white); the conversion of cryolite into sulphate of alumina, alum, and soda; the conversion of rock-salt into sulphate and carbonate of soda; the conversion of carnollite and kainite into chloride and bromide of potassium, sulphate and carbonate of potassa; the conversion of copper into verdigris and sulphate of copper; the manufacture of paraffin, and paraffin or crystal oils from peat, Boghead coal, and lignite; the preparation of kelp and iodine from sea-weeds; the manufacture of stearine-candles (stearic acid properly) and soap from oils and fats; the preparation of sugar and alcohol from starch; the conversion of alcohol into vinegar; the brewing of beer from barley and hops; the manufacture of pig-iron into malleable iron (puddling process), and the conversion of malleable iron into steel; the production of gas, coke, and tar from coals; the extraction from the tar of such substances as benzol, carbolic acid, aniline, anthracen, asphalte, naphthaline; the preparation of tar-colors, as rosaniline, aniline blue, Manchester yellow, Magdala red, alizarine, iodine green, picric acid, etc."

These illustrations of the scope and character of chemical technology give also an idea of the quality and range of Dr. Wagner's book. For twenty years he has held an eminent position in Germany as an authority upon technology, and his voluminous annual reports upon the subject have been the standards of reference in regard to its progress. The first edition of the present hand-book was published in 1850; and the eighth edition, which appeared last year, is now translated, and is the first that appears in English. The volume is a compact cyclopædia of the most recent and accurate knowledge on a wide range of practical subjects, and will be of great value to the industrial and manufacturing interests of the country.

**The Great Problem: The Higher Ministry of Nature viewed in the Light of Modern Science and as an Aid to Advanced Christian Philosophy. By John R. Leifchild, A. M., author of "Our Coal-Fields and our Coal-Pits," "Cornwall: Its Mines and Miners," etc., etc. With an introduction by Howard Crosby, D. D., LL. D., Chancellor of the University of New York. 543 pages. George P. Putnam & Sons.**

Mr. Leifchild's book, entitled "The Higher Ministry of Nature," has been republished by the Putnams, who have appropriately prefixed to it the title "The Great Problem." The general aim of the author, who is a semi-preacher and semi-geologist of London, is to show that the higher teachings of Nature confirm true religious faith instead of subverting it; but he feels it incumbent upon him to go into all the controverted questions of the time in theology, metaphysics, and science, and is equally ready in the treatment of theism, pantheism, the unknowable, Spinozism, Darwinism, evolution, morals, the correlation of forces, protoplasm, and other knotty matters too numerous to mention.

The American volume comes well commended to the public. A gentleman high in the honors of scholarship, and the responsibilities of education, and who presides over our metropolitan university, has prepared a compact and telling introduction to Mr. Leifchild's volume, in which he assures us that it is a work that strips off disguises and goes to the core of things. His decisive views are put in a narrow compass, so that we are happily enabled to give them complete to the readers of the Monthly. If any should happen to think that the volume lacks point and incisiveness, they will find this quality eminently supplied in the chancellor's brief prologue. When, however, he calls for a thousand such books, we

think he under-estimates the potency of a smaller number, for certainly, before a score had made their appearance, "The Modern Huxleys," whose skins are so ruthlessly stripped off, would call upon their eternal protoplasmic firmament to fall upon them and hide them forever from the calamities to come.

The author of the performance before us is of a most conservative temper, and refrains from altering even by a hair's-breadth any of the questions he has undertaken to discuss. All the conflicts, confusions, and obscurities of the subject, are faithfully reflected in his pages. For the alleged stripping off of disguises and plucking out the core of things, we have sought in vain, our impression being that this is exactly what the author has avoided. The assiduity with which he leaves things as he finds them is remarkable, and this trait gives a special value to his treatment of the subject. What is denounced by many people, Mr. Leifchild denounces, and what is indorsed by many other people, Mr. Leifchild indorses, and, if it happen to be the same thing, that is none of *his* business. Mr. Lyell's views of species are quoted, and then it is naively stated that Mr. Lyell has abandoned them —with Mr. Lyell be all the responsibility. His book may therefore be taken as having some value in indicating the various drifts of public opinion. Mr. Herbert Spencer is freely denounced by certain parties as the prince of materialists and the arch-enemy of all religion, because he is the leading exponent of the doctrine of evolution, and Mr. Leifchild joins in the condemnation, and quotes President Porter, of Yale, exultingly as the great "Spencer-crusher." But there are others who maintain that the doctrine of evolution is not necessarily atheistic, or materialistic, or destructive of religion, and with these also Mr. Leifchild is in equal accord. Lest the readers of Chancellor Crosby's introduction should be puzzled at this statement, and perhaps a little skeptical about it, we quote the following passages from "The Great Problem:"

"The earnest and increased study of Nature in our day leads us to much broader views of Divine action than have been formerly entertained; and to these views natural science conducts us without really leading us away from the Deity. Just as we now discover more and more geographically, so we discern more and more theologically. The earth is far larger to us than to Herodotus; Columbus was a far better geographer than the Grecian; but the discovery of America did not annul the existence of England or Spain. The discovery of new stars does not extinguish the old stars, does not darken one beam of their light. In like manner, the discovery of Natural and Sexual Selection, or rather the application of them, does not limit the action of the Creator" (p. 256). "The unity of Evolution, as comprehended by the Cosmos, is aptly described by Mr. Spencer, who shows the higher generalization of our knowledge concerning Evolution to be—so far as we know the constitution of the world—one unceasing and all-perfecting system, advancing everywhere and in all. After elaborately working out his own theory, Mr. Spencer suggestively intimates that the laws of Evolution, contemplated as holding true of each order of existence separately, hold true when we contemplate the several orders of existences as forming together one natural whole. While we think of Evolution as divided into Astronomic, Biologic, Psychologic, Sociologic, etc., it may seem to a certain extent a coincidence that the same law of metamorphosis holds throughout all its divisions. But when we recognize these divisions as mere conventional groupings made to facilitate the arrangement and acquisition of knowledge—when we regard the different existences with which they deal as component parts of one Cosmos—we see at once that there are not several kinds of Evolution having certain traits in common, but one Evolution going on everywhere after the same manner. While any whole is evolving, there is always going on an Evolution of the parts into which it divides itself. This holds true of the totality of things as made up of parts within parts, from the greatest down to the smallest. We know that, while a physically cohering aggregate like the human body is getting larger, and taking on its general shape, each of its organs is doing the same; that, while each organ is growing and becoming unlike others, there is going on a differentiation and integration of its component tissues and vessels; and that even the components of these components are severally increasing and passing into more definitely heterogeneous structures. But we have not duly remarked that, setting out with the human body as a minute part, and ascending

from it to the greater parts, this simultaneity of transformation is equally manifest; that, while each individual is developing, the society of which he is an insignificant unit is developing too; that, while the aggregate mass forming a society is becoming more definitely heterogeneous, so likewise is that total aggregate, the Earth, of which the society is an inappreciable portion; that, while the Earth, which in bulk is not a millionth of the solar system, progresses toward its concentrated and complex structure, the solar system similarly progresses; and that even its transformations are but those of a scarcely appreciable portion of our sidereal system, which has at the same time been going through parallel changes" (p. 260). "The more I can understand of the manner of Evolution, the more am I impressed with its unity of purpose, even in full view of its multiplicity of parts, and manifoldness of stages. From increase of such knowledge I rise into higher perceptions. I see rhythm in every motion on the earth, rhythm therefore in combined motions, a wonderful rhythm pervading the Cosmos" (p. 259). "What can we say of Evolution? if we treat it reverently, and not atheistically, we can only say that it presupposes an evolver, and that such an evolver must be Divine" (p. 257). "The manner of his unfolding is the true and limited province of physical inquiry; yet a noble province it is, rich in results, fair with flowers by the wayside, and abundant in promise for future ages. Men are observers of natural development; whether or not included in it; they watch its progress in other existences with deep interest. Every advance in it is fitted to impress the beholder with admiration, and to direct him not only to the advance itself, but to convert him from a mere interpreter of stage after stage into an obedient servant and reverent worshipper of the grand Evolver."

THE ANCIENT STONE IMPLEMENTS, WEAPONS, AND ORNAMENTS, OF GREAT BRITAIN, by JOHN EVANS, F. S. A., Honorary Secretary of the Geological and Numismatic Societies of London, etc., etc.

THE author of this work is the highest authority in England—perhaps the highest in the world—upon the subject of which it treats. A gentleman of extensive means and a laborious student, he has taken up that great division of Prehistoric Archæology which deals with the vestiges of man in the age of stone, and in the present volume we have the matured and comprehensive results of his inquiries. He has concentrated his main attention upon England, and given an exhaustive presentation of the evidence that has now been gathered, regarding the primitive state of the inhabitants of that island, when their implements of war and peace were chiefly constructed of flint. The volume is a valuable contribution to the obscure but interesting question of the antiquity of man, and the primeval conditions of his life. Mr. Evans is not a partisan, or a propagandist of any extreme views upon this subject, but deals with it simply as a scientific question, to be elucidated by the painstaking accumulation of the relics of antiquity which yet remain, and which are becoming more varied and abundant with increasing search and observation. He has figured in his pages about 800 objects—arrow-heads, daggers, knives, axes, hammers, adzes, picks, chisels, gouges, drills, scrapers, whetstones, stone-vessels, buttons, rings, necklaces, bracelets, and various other things—stating their locality and under what circumstances they were found. Great care has been taken with the illustrations, Mr. Evans having spared no expense in procuring the best artistic talent in order to secure the highest accuracy of representation. The book is valuable for the fidelity of its preparation, both in a scientific and artistic point of view, and, as it contains most of the information at present available with regard to the class of antiquities of which it treats, it will at once take eminent rank among treatises upon this branch of the natural history of man.

A MANUAL OF MICROSCOPIC MOUNTING, WITH NOTES ON THE COLLECTION AND EXAMINATION OF OBJECTS. By JOHN H. MARTIN. Philadelphia: Lindsay & Blakiston, 1872.

THE necessity of the microscope to the naturalist and physician, and its wide employment as a means of recreation and study by the non-professional, have created a demand for something that shall serve as a guide in the delicate operations connected with its use. So far as the management of the instrument itself is concerned, this has been supplied in various treatises; but, with the exception of incidental directions, wide-

ly scattered, and therefore not readily accessible, we do not remember to have seen any thing recent that would help the student in the preparation and mounting of specimens. Yet this is by far the most difficult part of microscopic work, and, after the management of the instrument has been learned, the beginner not unfrequently breaks down, or becomes sorely discouraged in his attempts to prepare and mount his objects. But, if he fails to master this department, all opportunity for original research is precluded, and he is compelled to rely on the use of purchased slides, which, often got up merely "to sell," are not always to be depended on. His need is a set of clear and explicit directions in regard to all the important details of this part of the work, and this the book before us appears well designed to fill.

Beginning with the illustrated descriptions of all the necessary apparatus, and minute directions for its use, there follow very complete explanations of the various methods of mounting, with careful directions how to proceed in each; and after this the manner of preparing specimens for the purpose of mounting is very fully treated. How to collect, label, and temporarily preserve all sorts of objects intended for mounting is next considered; and then we come to the seventh and last chapter, which gives instructions how to proceed in the examination of organic and inorganic substances, with tests for adulterations—a branch of microscopic work of much practical importance.

The book closes with an appendix, containing some seventy-five receipts for preparations useful to the microscopist, and a short explanation of how to convert and correct microscopic measurements. It is also provided with a good index.

THOUGHTS FOR THE TIMES. Sermons by the Rev. H. R. HAWEIS, M. A., Incumbent of St. James's, Westmoreland Street, Marylebone, London, Author of "Music and Morals," etc.

WE have read Mr. Haweis's "Thoughts for the Times" with much interest, and believe it is destined to make a deep and wholesome impression upon many minds. Books of sermons are getting to be very different things from what they were formerly, and this is one of the improved kind—a book of broad, liberal, and decisive views, applied to practical questions. It is a work of the type of "Robertson's Sermons," fresh and breezy with the stir of living thought, strong in criticism, and thoroughly hospitable to modern ideas. Mr. Haweis does justice to those whom sermonizers generally delight to denounce, and in his search for truth he does not neglect its latest forms. Instead of sounding the alarm-bell, and proclaiming the peril of religion at every step in the onward course of Science, he denies the antagonism, and is in no dread that faith will be destroyed by any discoveries that can be made concerning the order of Nature. While the whole book is pervaded by independent thought, and by a devotional and reverent spirit, the sermons upon the "Idea of God" and the "Law of Progress" are especially significant and instructive.

A COMPENDIOUS MANUAL OF QUALITATIVE CHEMICAL ANALYSIS, by CHARLES W. ELIOT and FRANK H. STORER. Revised, with the Coöperation of the Authors, by WM. RIPLEY NICHOLS. New York; D. Van Nostrand, Publisher, 1872.

No field of literature has been more cultivated, and yet with so little apparent success, as that of elementary text-books, and particularly is this the case in the department of science and technics. Every new effort in this direction is therefore fully deserving of all the encouragement which can conscientiously be extended to it. And we are sure that the little book on Qualitative Chemical Analysis by Messrs. Eliot and Storer deserves as full a measure of recommendation as the success of its first edition implies. It is a book especially adapted to the necessities of the beginner in this branch of chemical technics, and will leave him, if not inclined to pursue the subject into the higher details of analytical practice, with sufficient knowledge of the subject for the man of culture, or, if so inclined, will fit nim to erect the edifice of his chemical education on a firm foundation of elementary knowledge.

THE GARDENER'S MONTHLY.—The amateur in need of practical directions as to the laying out and tending of a garden, and the choice of plants, shrubs, etc., cannot do

better than to subscribe for this exceedingly valuable little monthly. He will there always find, in the "Monthly Hints," just the information he is likely to want, coming precisely in season for him; while in the department of "Communications" he will have detailed in brief the experience of some of the most successful amateur and professional gardeners in the country. A glance at the headings of the various departments of this magazine will perhaps best show the ground it is intended to cover. Besides the two already mentioned, we have the following: Editorial, Scraps and Queries, Book Notices, New and Rare Plants, Fruits, etc., Foreign Correspondence, Horticultural Notes. Mr. Thomas Meehan is the editor; and, this said, there is no need of further commendation of the magazine. $2.00 per annum. Philadelphia: Published by Charles H. Marot, 814 Chestnut Street.

THE BEE-KEEPER'S MAGAZINE (H. A. King & Co., 14 Murray street, N. Y.), the initial number of which is out, presents a very creditable appearance, and will no doubt be favorably received by the special public to which it is addressed. It has a very interesting table of contents, and a handsome chromo frontispiece, "A Group of Honey Plants."

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BOOKS RECEIVED.

Annual Report of the Director of the Meteorological Observatory, Central Park, New York, 1871.

Reports on the Observations of Encke's Comet during its Return in 1871. By Asaph Hall and William Harkness. Washington: Government Printing-Office, 1872.

The Health and Wealth of the City of Wheeling, etc. By James E. Reeves, M. D. Baltimore, 1871.

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## MISCELLANY.

**Facts relating to Niagara.**—We have received a letter stating that the article on Niagara Falls, which was published in the September MONTHLY, contains various inaccuracies, the following being the most important. The author of the article states that a barrier fifteen feet high, stretching across the plateau at the head of the rapids, would throw the water back on Lake Erie. Our correspondent objects that this barrier would have five feet of water flowing over it. The critic further states that the writer of the article blunders about the source of Gill Creek, in such a way as to require its waters to rise 350 feet before they could discharge into Niagara River; and, finally, the author of the article affirms that the falls, in cutting their way southward, have lost 35 feet in height each mile, which, in 6¼ miles, the distance to Lewiston, would amount to 227 feet, while our correspondent affirms that this loss of height is but 99 feet.

**The Monas Prodigiosa.**—In our common household experience we may often observe the sudden appearance of a phenomenon, which, as is remarked by a writer in the *Danziger Zeitung*, is of great interest, both from the historical and the scientific point of view. The writer says that housewives in Dantzic must have noticed blood-red spots making their appearance on farinaceous articles of food, when laid aside for a little while. This phenomenon has been often observed in that city lately, and is attributable to the presence in the food of a microscopic animalcule in the lowest stage of organic development, and consisting of a single mucous sac; though the botanist would perhaps class it among plants. It is probable that house-flies transfer from place to place these animalcules, which adhere to their feet, and thus occasion in provisions those apparent spots of blood which cause housewives so much annoyance. These animalcules acted an important and tragic part in the history of the middle ages, producing the phenomenon of *bleeding hosts* which repeatedly gave the signal for fearful persecutions of the Jews. It will be remembered that in those ages of fanaticism the Jews were often accused of stabbing the consecrated Host, and causing it to bleed, and on this charge over 300 Jews were at one time put to death in Basle, during the fourteenth century. Bolsena, a town in the late Pontifical States, was once the scene of a great miracle, produced by these animalcules. Down to the present day they exhibit at Bolsena, as a famous relic, the robe worn by a certain priest who,

in the act of consecrating the eucharistic elements, entertained a doubt as to transubstantiation, when suddenly he perceived on his alb (white robe) drops of blood, which had previously been concealed by the plaits of the garment. He hastened to hide the stain, but in the excited state of his imagination only saw the appearances of bleeding hosts multiplying. This wonderful occurrence (as it was then esteemed) gave occasion to the establishment of the festival of Corpus Christi by Pope Urban IV., and is the subject of Raffaelle's beautiful *Miracolo di Bolsena*, which he painted in the year 1512. The well-known *savant*, Ehrenberg of Berlin, was the first to attempt an explanation of the occurrence, by assigning natural causes for it. A Berlinese lady, having shown to him some potatoes boiled in their skins, and then laid aside for the space of one day, with a deep-red color appearing where the skins had burst, he discovered the existence, at the broken places, of a microscopic animalcule $\frac{1}{300}$ to $\frac{1}{800}$th of a line in diameter, which he recognized as the cause of the phenomenon. In memory of the marvels wrought by the creature in past times, he gave it the name of *Monas prodigiosa*—the miraculous monad.

**"The City of the Future."**—There is a tendency among the more comfortable classes to make cities merely places to work in, but to abandon them for the country as soon as business is over for the day. Mr. O. B. Bunce, in APPLETONS' JOURNAL, opposes this movement, and claims for city-life superiority over country-life, in almost every respect. He proposes to utilize the pure air above our heads, by erecting buildings of many stories, with steam-elevators and every modern convenience. This would bring the entire population within easy reach of the theatre, lecture- and concert-hall, art-gallery, museum, etc. In short, the writer makes out a strong case for the city, as regards intellectual life. Then come physical health and comfort. It is an error to suppose that the city is less salubrious than the country; a walk up Broadway is sufficient to prove this. Dyspepsia, rheumatism, and diseases arising from damp houses and undrained lands, are more common in the country. The city, too, is not subject to the plague of mosquitoes. The writer would have city people employ all the resources of science, to evolve from their surroundings all the health and comfort, all the enjoyment and intellectual life, which the town can afford.

**An Aged Carp.**—The following remarkable story concerning the age of a carp recently killed at Chantilly, while fighting with a pike, is told by the Paris *Gaulois:* "It was the oldest carp in the world, being 475 years of age, and belonged to M. C——, the proprietor of a fine property at Chantilly. It was an historical carp, a carp which was born at the Comte de Cosse's, in the time of François I.; it had passed through various fortunes, having had no less than thirty-two masters. M. G—— purchased it a year since for 1,300 francs. The name of the carp was Gabrielle, and it measured nearly $29\frac{3}{4}$ inches round, and $38\frac{3}{5}$ inches in length."

**The Potato-Disease.** — According to recent statements in the English papers, one of the most serious of the multiplied ills from which England is now suffering is the almost total failure of this year's potato-crop, due to the attack of a parisitic fungus peculiar to plants belonging to the same natural order as the potato. This affection, which is known as the *potato-disease*, or more commonly *rust*, was first observed in Germany in 1842, where it assumed a serious character. In 1844 it broke out in Canada, and did a great amount of damage. In the following year it was first noticed in England, and in 1846 prevailed all over Europe, but was most destructive in Ireland, where it gave rise to the celebrated Irish famine. The mycelium of this fungus eats into and completely destroys the tissue of the leaf and stem, and, when once its ravages have commenced, there is little hope of arresting them. From the leaves and stem the disease frequently extends to the tubers, where it sometimes lies dormant for months, so that, after being stored, apparently sound in autumn, they become affected in the following spring. When the disease appears in the growing plant, brown spots are first seen on the margins of the leaves, corrugating them as they spread. Very rapid

extension of the disease, and decay of the leaves and stalks, often ensue. *Botrytis infestans* is the name applied to the fungus, and it is on the under surface of the leaf that it is generally found; it abounds also in the diseased tubers, which, when cut, produce an abundant crop from the fresh surface, and it sometimes vegetates even from the natural skins. The *resting spores* of the fungus may lie dormant through the winter, germinating the next season; and hence, though the eyes of a diseased tuber appear healthy, to plant them would be the certain means of spreading the disease. The same fungus has been found in the berries of the tomato when diseased, and on the leaves of other plants of the natural order *Solanaceæ*, but never on any plant not of that order.

The influences which favor the development of *Botrytis* are not well understood. It is most prevalent, however, in cloudy, moist summers, and all authorities agree that it makes its first decided appearance during thundery weather. The exceptional amount of electrical disturbance which extended over almost the whole of England, during July last, appears to have been most unfavorable to the potato-crop, but in a portion of the county of Devon, where thunder-storms are remarkably rare, the potatoes are said to be comparatively free from the disease. The most destructive outbreaks of the blight have been observed to recur at intervals of about twelve years. In 1846, as before mentioned, the disease was general in Europe, and in some places, as in Ireland, it swept away the entire crop. From 1859 to 1861 it again did a great amount of damage; and now, in 1872, it is more destructive than at any time since 1846. The London *Times* states that the loss to the country from the destruction of the present crop will exceed twenty millions sterling, and very pertinently asks: "What are we doing, or what have we done, to obviate the recurrence of a disease which is always impending? Probably all we can remember is, that there is always a talk of the potato-rot, and that some years it has been worse than others. We can only say that this is a disgraceful confession. There is no matter in which science could interfere with more advantage; and we seem to have all the conditions of the subject under control." *Nature*, in an article upon the subject, admits the force of these remarks, and, pointing out the reasons why neither individuals nor societies should be expected to undertake the work, urges that the government appoint a commission to investigate the origin, course and remedies for the potato-disease.

"Little objection can be anticipated to the course we advocate, on the ground of the money value at stake in the question. We are at the present time spending a large sum of money and employing the highest talent in the country in the settlement of a claim for a few millions; to save the country several times as much per annum cannot be objected to as a matter unworthy the attention of our rulers. And yet, because the one infliction will fall upon us in the form of an additional twopence to our income-tax for a single year, the other in the form of a much heavier addition to our butchers' and greengrocers' bills for many years in succession, we are content in the latter case to grumble and bear it, without making any serious efforts to relieve ourselves from it. Science is often charged with being 'unpractical;' indeed, in the minds of perhaps the majority of people, there is a kind of hazy feeling of a necessary antagonism between what is scientific and what is practical. It is time for science to redeem herself from this imputation, and no better opportunity could be found than in discovering a remedy for the potato-disease."

**Action of Plaster on Soils.**—Though generally employed by farmers as a fertilizer, the action of plaster (gypsum) on the soil is not well understood. It has been shown, however, by actual experiment, that plaster is capable of absorbing ammonia from the air, and also from decomposing animal and vegetable matter, holding it in the form of sulphide of ammonium. This, again, may be changed into carbonate of ammonia, by absorption of carbonic acid from the air. These changes occur when gypsum is brought in contact with moisture and vegetable matter. Whatever other purpose it may serve, this must be regarded as the most important, as by it plants are supplied with food of the highest value.

From this fact it may be inferred that

plaster must prove highly serviceable to moist, mossy hills, and also to meadows that are not too wet. The north side of a hill is sometimes greatly benefited by plaster, when upon a southern exposure it produces no perceptible effect. It may be used with confidence on pastures and fields which are strong enough, and moist enough, to support deciduous trees. A hill-side, where moss will grow so as to crowd out good grasses, is, usually, promptly benefited by plaster, white-clover quickly following its application.

**Facts about Glass.**—Common greenish glass is found to change color under the influence of the sun's light, becoming first yellow, then rose-colored, and finally violet. And even the purest white glass is found sometimes to undergo the same changes. Thus M. E. Siegwart, from whose monograph on "Glass Manufacture," we gather these items, found the abductor tube of a chlorohydric gas apparatus deeply tinged with violet at the parts exposed to sunlight. When fused anew, the original color returns to the glass. It is commonly supposed that glass is not corroded by the atmosphere, nor even by strong acids. But this is an error; for Siegwart found, on actual experiment, that the exposed surface of glass combines with the constituents of the air. If glass is suffered to cool very gradually, it undergoes a transformation which is in most cases visible to the eye. At first there appear specks, which soon dot the entire surface. The glass now becomes cloudy; and finally changes into an opaque body like porcelain, and called Réaumur porcelain. This *devitrification* is the most remarkable phenomenon in the manufacture of glass, and explains several of the *faults* found in that material.

**War and Insanity.**—It was supposed that the disasters attending the late war had had the effect of increasing the number of insane persons in France, but statistics, so far from confirming this conclusion, show rather that the number of insane patients was smaller during the year ending July 1, 1871, than during the preceding year. Dr. Lunier, who has studied this subject, shows that in 1869–'70 there were admitted into the asylums 11,165 patients; whereas for the year of the war and the insurrection the number was 10,243. Of these 10,243 patients, 1,322 became insane by reason of the calamities produced by the war. During the first half of the year after the war, 400 patients were admitted who had lost their reason from the same cause. The sum total, therefore, of such cases is between 1,700 and 1,800; and the asylums now contain 3,000 less patients than in 1869.

**Parliamentary Ventilation.**—After spending immense sums of money, and trying numerous methods, the ventilation of the English houses of Parliament is still exceedingly imperfect. The system now in operation is one of exhaustion, or in other words one of suction, the air within the building being sucked out, and, to supply its place, the surrounding external air is sucked in, no matter how impure or how unfit for breathing purposes it may be. This plan is condemned by a writer in the *Journal of the Society of Arts* on the following grounds: Exhaustion creates a partial tendency to a vacuum, when, to maintain the atmospheric equilibrium, the surrounding air rushes in from every quarter. Impure sources are thus as likely to be drawn upon as any other, and the air introduced is scarcely an improvement on that withdrawn. The tendency to a vacuum also favors the occurrence of draughts. Every chink about a door or window, and every crack in the wood-work, becomes an opening for the admission of cold damp air in the shape of a sensible current. A system of suction also perceptibly affects the acoustic properties of rooms to which it is applied. The reason for this is that, whenever there is a partial vacuum, in the same ratio as that has been reached, has the power of the air to transmit pulsations of sound been impaired.

**Preparations for observing the Transit of Venus.**—The French are making active preparations for observing the approaching transit of Venus, the Assembly having voted $20,000 for the construction of instruments, with the promise of $40,000 more during the coming year. Nine sta-

tions have been selected for observation, at four of which the entrance and exit of the planet will be visible, while at the other five but one of the two incidents can be observed. French *savants* are now corresponding with the astronomers of England, Germany, Russia, and this country, with a view to parcelling out the stations to the different observers in such a way that all shall be favorably located, and all the useful points of the earth's surface available for these important observations occupied. After use in 1874, the French apparatus will be carefully preserved for observing the transit of 1882, which is followed by a period of one hundred and twenty years, in which no transit occurs.

**The Boring-Organ of Pholades.**—It is well known that certain molluscous animals have the power of boring their way into solid substances, making the hole thus excavated their future home. The *teredo* or ship-worm, for example, honeycombs the densest timber, others excavate in clay or chalk, and *pholas* perforates the hardest rocks. With what part of the animal the work is accomplished has long been a matter of dispute, some zoologists regarding the rough, rasp-like shell as the perforating organ, while others believe that the work is done by the foot. In a paper on the subject, read at the recent meeting of the British Association, Mr. John Robertson adopts the former view, maintaining that the perforations are made by the rotating movements which the creature is capable of imparting to its shell. In the discussion which followed, Mr. Bryson, a close observer of the habits of *pholas*, was quoted to the effect that the boring is accomplished by the foot, which, charged with siliceous particles, acts like the leaden wheel of the lapidary. Mr. Gwynn Jeffreys also regards the foot, in all the boring *Conchifera*, as the instrument of perforation. Several facts were cited in support of this. In *Teredo navalis*, as was long ago shown by Sellius, the foot is the only organ of perforation, and the posterior extremity of the shell has a large excavation into which this organ is received. *Pholadidea* in the young state excavates by means of the foot, but afterward the aperture becomes closed by gelatinous matter, when no further excavation takes place. In *pholas*, also, no part of the shell can act at the bottom of the excavation, the foot alone being capable of use in that position.

**The Polaris Expedition.**—Captain C. F. Hall writes, under date August 24, 1871, from Tossak, North Greenland, that all goes well with his vessel, the Polaris. The captain has abundant supplies, and is well provided with Esquimaux dogs, reindeer-furs, seal-skins, etc. Hans Christian, well known to readers of Kane's narrative, accompanies the Polaris Expedition, together with his family of wife and three children. Various charts and notes of Baron von Otter, commander of the Swedish Expedition, and of other scientific men, are in the possession of Captain Hall, and have led him to abandon the Jones Sound route; to cross Melville Bay to Cape Dudley Diggs; and thence make for Smith's Sound, with a view to reach Kennedy Channel.

**Disastrous Volcanic Eruption.**—A very violent eruption of the volcano of Merapi, in Java, took place on the 15th of April. The event was totally unexpected, and the loss of life and property was great, many villages being destroyed. In some places the ashes fell for three days, and it became so dark that lamps had to be lit. About 200 dead bodies had at last accounts been found on one side of the volcano.

**Chemical Products of Eucalyptus.**—Eucalyptus is the name of a genus of trees containing many species, mostly natives of Australia, where the tree is very abundant. Several species yield a copious resinous secretion, and are therefore known as *gum trees*. Some of these attain a great size, it is said, exceeding in height the giant red-woods of California. The bodies are slender and without branches, except near the top, where the branchlets droop like those of the weeping-willow. The leaves are entire, of a leathery texture, and, instead of being placed with one surface toward the ground and another toward the sky, hang with their edges in these positions, so that the two surfaces of the leaf are equally exposed to the light. The trees are of very rapid growth, and fur-

nish a timber that when green is soft and easily worked, and that when dry becomes very hard. Eucalyptus has been introduced with success both into Europe and California, and the valuable character of the tree is becoming more and more appreciated as its properties are better known. Ramel first brought it into Europe in 1856, and it has since flourished in the southern portion of the continent. As far north as Paris, however, it does not thrive, the winters proving too cold for it. Owing to the great absorbent power of its roots and leaves, and the fact that the latter yield a strong aromatic odor, the tree is regarded as peculiarly suitable for marshy and unhealthy districts. The leaves contain a notable quantity of a volatile aromatic oil, and afford, both in the fresh and dry state, a very fluid essence, which is slightly colored, and gives off an aromatic odor that reminds one of camphor.

The following preparations are at present manufactured from *Eucalyptus:*

1. The essence already spoken of, which is administered in doses of a few grms. in the form of globules.

2. Leaf-powder, which contains all the active principles of the plant (essence, tannin, bitter principle), and which is prescribed in doses of 4, 8, 12, and even 16 grms. daily.

3. The infusion and decoction of the leaves. With half a leaf (about 1 grm.) it is possible to aromatize three or four cups, affording a good substitute for tea. This is employed as a stimulating drink. For topical applications, 8 grms. in decoction, in a litre of water, forms a liquor well charged with the principles indicated.

4. Water distilled from the leaves, which may be advantageously used with stimulating drinks.

5. Aqueous extract, alcoholic extract, employed as febrifuges.

6. Tincture or alcoholate.

7. A liquor, which is similar to the liquor of mastic, and a wine, which is a tonic and febrifuge.

8. Cigars and cigarettes.

Dr. Gimbert has studied on himself the effects of essence of *Eucalyptus* when taken into the system. He took various doses of from 10 to 20 drops, and found it had a soothing effect. It diminishes the vascular tension, and the sense of comfort arising from it induces sleep. A very strong dose produces temporary excitement, headache, and slight fatigue.

**New Method for disintegrating Wheat.**—An inventor of Bristol, England, has contrived a mill for reducing wheat to flour, which is said to do the work much more rapidly than millstones, and at the same time yields a vastly superior product. The arrangement consists of iron cages containing revolving radii, driven at the rate of four hundred revolutions a minute, which almost instantaneously reduces the wheat to powder. At Edinburgh two such mills have been running for more than a year. Each one does the work of twenty-seven pair of ordinary millstones, with a saving of five and a half per cent. in favor of the new mill. The bread made from the flour which this mill turns out is pronounced remarkable for its lightness and good keeping qualities.

**Instinct at Fault in a Humming-Bird.**—Says a correspondent in the Bulletin of the Torry Botanical Club: "I was reminded the other day of the story told by Pliny, of the painter Zeuxis, who represented a bunch of grapes so naturally that the birds flew at the picture to eat the fruit. My friend Mrs. P. W. told us that a gentleman, the Rev. Mr. P., was sitting on the piazza of her house with his feet encased in a pair of worked slippers, adorned with some highly-colored flowers, and that she saw a humming-bird repeatedly peck at the flowers, in the vain attempt to find in them his accustomed nourishment. This curious fact seems to indicate that the attraction in such cases is not due to the odor of the flowers, but simply to their bright color; and that the Greek story is not so improbable, after all."

**White Partridge-Berries.**—Of this berry, sometimes called Squaw-berry, and which is normally a brilliant scarlet, a good many white ones were found this autumn at Canaan, Conn. The white berries grew on separate vines, ripened like the red ones, but were much larger.

**An Army of Caterpillars.**—A writer in the *Gardener's Monthly* gives some interesting particulars concerning the habits of the caterpillars, which last spring visited the region about Memphis in such unheard-of numbers. They were so numerous, that several trains of cars coming into the city were stopped on each of the two roads, the masses covering the rails for hundreds of yards in a body, compelling the brakemen to get down and sweep them off before the driving-wheels could get sufficient hold to pass over the obstruction. They lived on the young leaves of both forest and fruit trees—the oak, quince, apple, and plum, being their favorite food. Whole orchards were denuded of foliage, and great lanes of bare trees marked their track through the forests. They are characterized by one remarkable peculiarity. Unless prowling through thick grass, or when about half grown, descending by the long web which each spins, from a tall rough forest-tree, they are always arranged in military style; and travel, also, in long, straight lines, several abreast.

**Insect-Life in a Coal-Mine.**—A coal-pit in England having become infested with large-winged insects, which caused the workmen considerable annoyance, by flitting around their lamps and often extinguishing them, a search was made to discover the source from which they came. The wooden props supporting the workings were found to be pierced in several places, as though by gimlets, and in the holes were found a number of moth-like insects. The wood had come from abroad, and had been in the pit some four years before the insects began to make their appearance.

**An Unpatentable Pavement.**—A writer in the *Journal of the Society of Arts* advocates the adoption of a kind of wooden pavement for the streets of London, which in point of wear he believes to be superior to all other varieties of wooden pavement, and with the additional advantage that it cannot be made the subject of a patent. He says: "Now, the only wood pavement fit to stand London traffic, and entailing the smallest cost, could not be patented by the most astute lawyer. Instead of fashioning the blocks into patent dice, hexagons, polygons, or dove-tailed complications in any form, we have only to slice barked trees of any size or quality into cylindrical slices about thirteen inches in thickness, and put the largest size down first into a good rammed foundation, and then the smaller sizes, until the remaining interstices may be filled up with what may be called pegs, the proper ramming of which will render the whole one solid mass of timber, while the economy of wood is so great that not a chip will be wasted. The surface will present end-grain only, and with the different sorts and sizes will afford a much better foothold than granite blocks."

**Gold in Sea-Water.**—In a series of researches on the composition of sea-water, a chemist named Sonstadt has been able to make out the presence of gold as one of its constituents. It appears to be completely dissolved, and is held in solution by the action of iodate of calcium, which, as shown by the same chemist, sea-water also contains. He demonstrates the presence of gold by three separate and entirely different methods, and estimates the proportion to be less than one grain per ton of water.

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## NOTES.

Non-inflammable Fabrics.—Cotton or linen goods may be rendered non-inflammable by being dipped in a solution of equal parts of acetate of lime and chloride of calcium dissolved in twice their weight of water.

Paper Lamp-Shades.—Dr. Mirus mentions two cases in Jena and one in Frankfort where persons using green glazed paper lamp-shades were poisoned by the arsenic of the coloring matter. The heat of the lamp volatilized the arsenic, and rendered the small quantity present very dangerous.

Progress of Chemistry.—One by one the organic products are being copied in the laboratory. The last triumph in this direction which has come to our notice is the production of glycerine by Friedel and Silva. If the vapor of fusel-oil be passed through a red-hot tube, propylen is formed, which readily combines with chlorine, and from this chloride of propylen glycerine is produced by a process in which no glycerine is employed. As glycerine is the base of all true fats, this is an important step in the direction of oil-making.

An officer connected with the Geological Survey of Ireland, Mr. Hull, states the net available tonnage of coal in that country as 182,280,000 tons. Of this amount, Antrim has 16,000 tons; Tyrone, 32,900,000; Queens, Kilkenny, and Carlow, 77,580,000; Tipperary, 25,000,000; Clare, Limerick, and Cork, 20,000,000. Connaught has 10,800,000.

According to J. Ballynski, if the motion of a leaden bullet were all converted into heat, it would amount to three times as much as would be sufficient to melt the quantity of lead found to be melted by actual experiment. This he explains as having been expended in denting the iron plates of the target. By using a hard stone target, he was able to completely melt the bullets fired against it.

An improvement has been made in the process for extracting sugar from the beet by maceration, by adding lime to the liquor and precipitating the lime by a current of carbonic-acid gas. This has the effect of rapidly purifying the liquor and of displacing the remaining air, which would otherwise promote fermentation.

Mr. Wideman states that, by the contact of ozone for twenty minutes with whiskey, the fusel-oil was removed, and the whiskey mellowed as much as if it had been kept for ten years. Further, by adding to whiskey of proof strength seven times its weight of water, the introduction of ozone speedily transformed the mixture into marketable vinegar. In Russia good brandy is said to be made from mosses and lichens.

Paper from Wood.—A letter from Berlin, in the *Elberfeld Gazette*, represents Prince Bismarck in a new light—that of a paper-maker. The paper-manufactory established by the Imperial Chancellor on his estate at Varzin has proved so successful, says the writer, that it is impossible to meet the large orders which come from England. This paper is made of chips of fir—that, at least, is the chief element.

An instance of supposed mimicry in insects is given in *Science Gossip*. The carpet-moth hides in some obscure place during the day, holding the upper wings outspread. When it thus rests on a greenish or obscure ground, it might easily pass for a smaller whitish moth. Is it by mere accident that the upper rather than the lower wings of the insect are spread out, or have we here a provision made to guard against the assaults of its enemies?

The French are making preparations for meteorological observations at elevated points. An observatory is now in course of construction at the summit of Puy-de-Dome, which will be connected by a telegraphic wire with another in a pavilion of the faculty at Clermont. The difference in height between the two is about 3,800 feet, and, by means of the telegraphic wire, the difference of meteorological conditions between the plain and the upper regions of the atmosphere can be shown at any moment.

The opium-poppy in Bengal is suffering serious damage from a fungoid growth which develops itself on the leaves. Sulphur is suggested as a remedy, it having proved useful in a similar disease which attacks the vine.

Timber-Planting in Hall County, Nebraska, has become quite popular. It is predicted that within twenty years the "Great American Desert" will be far better timbered than the Eastern States.

Hops in England.—Says the *Mark Lane Express*, 65,600 acres are devoted to the culture of hops in England, and the area is gradually increasing. Kent, the largest hop-growing county, had 32,000 acres in this crop last season, the early grounds averaging 1,400 to 1,600 pounds per acre; Sussex, next in importance, 14,500 acres, averaging 1,800 to 2,200 pounds per acre. Surrey is noted for a choice quality of hops of bright color and superior aroma.

A correspondent calls attention to a discrepancy of statement occurring in the article entitled "Coal as a Reservoir of Power," published in No. 6 of The Popular Science Monthly. It is there affirmed that a pound of coal in burning yields an energy equal to the power of lifting 10,808,000 pounds one foot; and this is followed by the statement that a cubic yard of coal, 2,240 pounds, possesses a reserve of energy equal to lifting 1,729,200 pounds one foot high: 2,240 pounds (an English ton) would of course yield 2,240 times as much energy as one pound, and consequently would raise 10,808,000 *tons* one foot high.

The extraction of sulphur and the manufacture of sulphuric acid from iron pyrites were first successfully accomplished on the large scale, under the stress of a tyrannical proceeding on the part of the King of the Two Sicilies. At the time, the island of Sicily was the principal source of the sulphur consumed in Europe, and the trade in the article brought an immense revenue to the government. A corrupt administration and a bankrupt treasury led the king to grant a monopoly of the business to a single firm in France, he expecting thereby to secure a large increase of funds. His action had exactly the opposite effect. The price of sulphur was doubled, its extraction from pyrites followed, and the sulphur mines of Sicily have since been of comparatively little consequence.

DAVID LIVINGSTONE.